THE JOURNAL

OF

Indian Botany

VOL. I.
September 1919—May 1920.

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V

METHODIST PUBLISHING HOUSE, MADRAS.

THE ORGANIZATION OF THE INDIAN BOTANICAL SOCIETY.

There has long been the need for organization of the scattered and isolated botanical interests of India. At the Nagpur meeting of the Indian Science Congress in January, 1920, the Botany Section decided to organize an Indian Botanical Society. A Committee consisting of Prof. W. Burns, D.Sc., of the College of Agriculture, Poona; Prof. P. Brühl, Ph.D., of the University College of Science, Calcutta; Prof. Shiv Ram Kashyap, M.Sc., of the Government College, Lahore; Rai Bahadur K. Rangachari, M.A., L.T., of the Agricultural College, Coimbatore; Prof. Borbal Sahni, D.Sc., then of Benares Hindu University, Benares; and Prof. Winfield Dudgeon, Ph.D., of Ewing Christian College, Allahabad, Chairman, was constituted to carry out the details of organization. The membership of the Society has now (December, 14, 1920) reached 71, and includes men engaged in all branches of botanical service from all parts of the country.

When the membership had reached 40, an election was held by correspondence, and the following officers were elected :—Dr. Winfield Dudgeon, President; Dr. W. Burns, Vice-President; Prof. Shiv Ram Kashyap, Secretary-Treasurer; Dr. Borbal Sahni, Councillor for two years and Rai Bahadur K. Rangachari, Councillor for one year. The President and Vice-President will serve through 1921, when the President will become a Councillor for two years; the Secretary-Treasurer is elected for a period of three years. The Officers and Councillors will constitute an Executive Committee to transact the business of the Society between annual meetings.

The purposes of the Society are several, though it may take years to realize some of them. The Society should promote a feeling of fellowship among Botanists, and draw them together for mutual benefit; help to improve the quality and content of botanical instruction in the various colleges and universities, provide Botanists an organized means for dealing with other organizations; and promote and encourage research in Botany, by advice and encouragement to beginners in research, by organizing botanical trips and expeditions of various kinds; and perhaps finally by establishing one or more Biological Stations in suitable locations. It should provide a central exchange for aiding Botanists in securing teaching and other appointments, for ideas, opinions, methods, and information generally, and for specimens, slides, research material, etc.; and finally, it should make more available to members the scattered and insufficient botanical literature that reaches India.

Conditions for membership have been fixed so that all who are truly interested in any phase of Botany are eligible. "Membership shall be open to all graduates who are interested in any phase in Botany; to non-graduates who have pursued advanced studies in Agricultural, Forestry, or other institutions, or who have distinguished themselves in research; and to such others as in the judgement of the Society are worthy of membership." There is no initiation fee. The annual dues have been fixed at Rs. 5, or when combined with a subscription to the Journal of Indian Botany, at Rs. 2-8-0. It is hoped in this way to encourage members to give their support to the only strictly botanical Journal in India.

All who join before the meeting of the Science Congress at Calcutta, January 31 to February 5, will be considered as Charter Members. Anyone who is eligible may become a Charter Member by remitting his dues to the Chairman of the Committee of Organization.

The Society will be affiliated with the Indian Science Congress in some way yet to be determined, and during the Calcutta meetings of the Congress the first meetings of the Society will be held.

EDITORIAL RETROSPECT

Eight months ago the Journal was launched with a mixture of hope and doubt, but a determination to succeed, and it may not be without interest briefly to review its progress. The object, as explained in the circular inviting contributions, and in the first editorial. was to be the publication, in the first place, of original botanical work done in India or on Indian plants, which would not naturally appear in the existing, somewhat technical, journals of this country and, in the second, of abstracts or reviews of other papers likely to be of interest to workers in India. Though supported by nearly every important botanist in India, the proposal met with misgivings from several who thought the "times were not yet ripe." "You will be fifty years in advance of your time" wrote one friend; "It may start all right but will soon fizzle out" said another.

The idea was for quite a moderate journal of about 24 pages, but to appear monthly, so as to allow of rapid publication of work. The first number appeared in September, and except in February, when pressure of other work at the Press prevented publication, and the next was therefore a 'double number', the issues have been monthly. The present and the January issues are also 'double', so that in the eight months ten numbers have appeared with an average of over thirty pages of original matter and diagrams and about four of abstracts to each. The original papers have been on nearly every branch of pure botany, *i.e.*, on Fungi, Algae, Liverworts, Mosses, Gymnosperms, the taxonomy of flowering plants, General and Physiological Histology and Morphology, Physiology, Oecology and a Systematic Flora of a country. Abstracts and reviews have appeared of over 50 papers and books, and occupied 40 pages of small type.

All this has been possible only with the active co-operation of botanists in India who have not only subscribed to the Journal, but also contributed to its pages: and it proves, I think we may claim, that the Journal has met a need, that botanical work in India was advanced enough for it, that the times were ripe. It remains to disprove the pessimist and keep the Journal alive. I have no fear about this. The Journal has started successfully, and won't fizzle out. It now circulates all over India,—though Bengal rather lags behind the other Provinces—in Canada, the U.S.A., England, Italy, Ceylon, Singapore, Australia and even Fiji: and without doubt the close of another year will see it covering a wider area and with

many more readers. Contributors may therefore feel assured that their work will not be lost to the scientific botanical world.

At the same time the Journal does not quite pay its way and has had financial assistance from the generous guarantor, Mr. T. R. D. Bell, C.I.E., who recently retired from the Office of Chief Conservator of Forests, Bombay Presidency. We need therefore all the subscriptions we can get, and we look to subscribers not only to continue their support but also to induce others to join.

P. F. FYSON.

THE

Journal of Indian Botany.

VOL. I. SEPTEMBER, 1919. No. 1.

EDITORIAL

This JOURNAL OF INDIAN BOTANY has been started to provide a means of publishing botanical work done in India, which would not naturally find a home in the existing botanical journals of this country, *e.g.*, the Records of the Botanical Survey and the various publications of the Agricultural Departments. The need for something of this kind has long been felt and frequently expressed, for without doubt much good work has been done in India in branches other than Floristic or Agricultural Botany, which has too often been laid on one side for lack of facilities of publication. The present venture owes its inception in the first place to the enthusiasm of Mr. L. J. Sedgwick, F.L.S., a keen and prolific worker in systematic botany, who, however, is unable on account of his official work to undertake the editorship; and in the second to Mr. T. R. D. Bell, C.I.E., who generously came forward with an offer to guarantee the expenses till the Journal should be so far established as to pay its way, or prove unwanted.

The chief object of the Journal will be the publication of original matter, and in order that any work may see the light without undue delay, the editor is prepared to issue the Journal monthly, provided of course that there is sufficient matter to go to press. At the same time he feels constrained to remind Indian Botanists that if they really want the Journal to live they must support it by sending to him the papers they would otherwise have sent elsewhere.

In addition to original papers we propose to publish abstracts and reviews of papers which appear in other journals; but since the editor cannot undertake to abstract all, even of those papers which come under his notice—and there must be many that do not—he will be glad of assistance in this. Several botanists have kindly undertaken to abstract papers, but more help is needed, and it is

hoped that these abstracts will be a regular feature of the Journal, and be of use in keeping Indian workers in touch with what is being done elsewhere.

Finally the editor appeals for subscriptions from all botanists in India, and from those in other countries who are likely to find work done here of interest or help; for to justify itself the Journal must pay its way.

Here, then, is a simple statement of our aims and wants in connection with the Journal; Guarantor, Editor and Publisher are prepared to do their share to make the Journal a success, it is up to Botanists in India to do theirs.

The Honorary Editor.

DIMORPHIC CARPELLATE FLOWER OF ACALYPHA INDICA, *L.*

BY

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Acalypha indica L. is a common member of the Euphorbiaceæ growing over most of India as a weed on waste ground. It is said by Hooker to grow over a wide tropical area, from the Philippines to Tropical Africa.

The flowers are apparently in spikes; but a closer examination shows that the flower cluster is in reality a racemose cyme, each of the branches from the main axis being a cyme, of three or more flowers. The lower branches, which are almost concealed by large bracts, bear trilocular carpellate flowers closely resembling in structure the carpellate flowers of *Ricinus* and the Euphorbiaceæ in general. Higher on the axis and with much smaller bracts are cymes of staminate flowers, while at the very tip without a bract is a peculiar bilaterally symmetrical unilocular carpellate flower which bears a single seed. This flower has three or four sepals which vary considerably in their position, and a monocarpellary pistil. The ovary is a transverse cylinder slightly depressed at either end and resembling a muff in appearance. The attachment of the stalk and sepals is to the curved surface midway between the ciliate-bordered ends. Arising from this point of attachment is the style. It resembles the style of a single carpel of the trilocular pistil except for its basal position and the fact that it is more fimbriate, having six to eight thread-like branches instead of three to five.

As the flower develops into the fruit the upper part of the cylinder elongates so that in its front or rear aspect the fruit is triangular with its apex downward. The edges are extended as hollow auricles which are fringed and rugose. The whole appears like a rhombic leaf bent so that the tip touches the base and enclosing a seed at its center.

To determine the significance of this terminal flower, inflorescence tips of various ages were killed in chrom-acetic acid, imbedded in paraffin, and sectioned. It was found that this flower starts as a

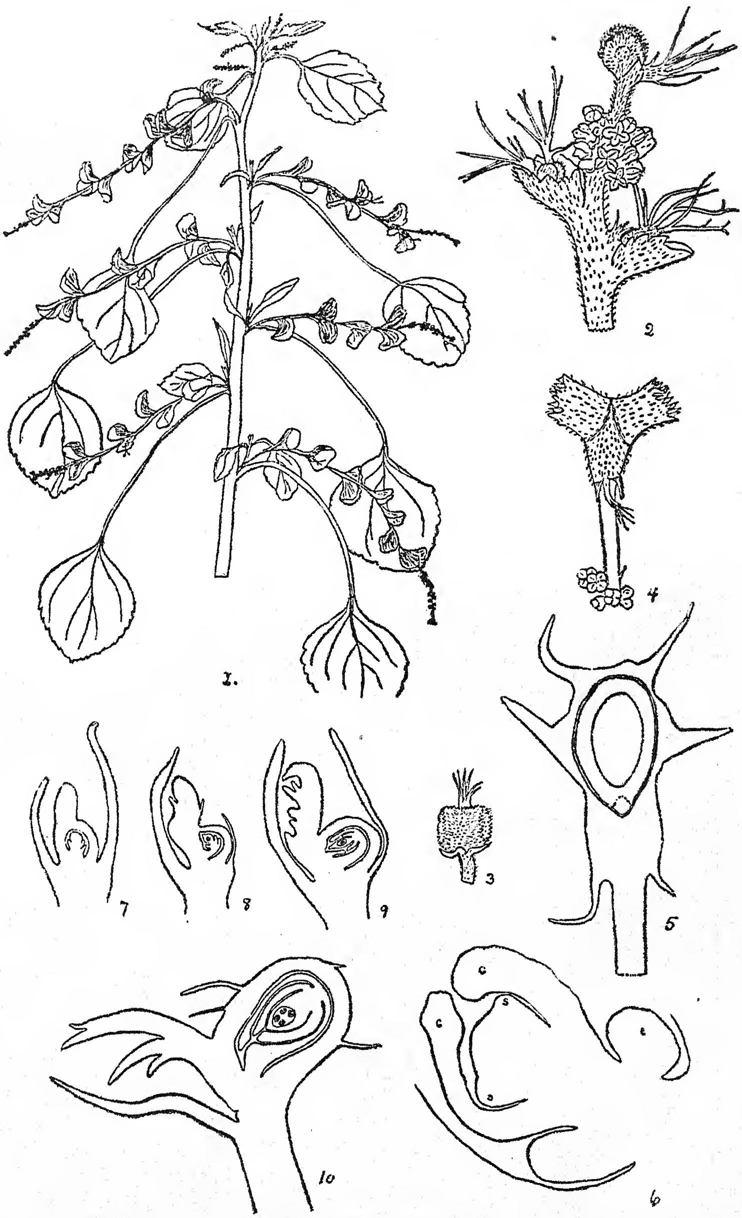
single carpel, there being no trace of other carpels, and that this carpel resembles in structure and appearance one of the three that make up the tricarpellary pistil. In both cases the style is terminal and the ovary orthotropous at the beginning. As development takes place in the monocarpellary flower, one side of both ovary and ovule greatly outgrows the other so that the micropyle of the anatropus ovule faces the style, which appears to come from the base of the ovary. In the polycarpellary flower, the conjunction with other carpels prevents any one carpel bending to bring the style into a basal position. But the ovule becomes bent in the same direction as in the terminal flower, the funiculus being lifted and folded against the ovule by the elongation of the common axis of the three carpels. The result is a half-inverted or amphitropous ovule with the funiculus joining the common axis about one-third the distance from its top, and with the microphyle at the upper end and not far from the base of the style. It will be seen that development in both cases keeps the micropyle near the base of the style in the most favorable position for the ready entrance of the pollen tube.

The obturator, a mass of cells observed by Baillon (1) as growing from the placenta toward the micropyle of certain Euphorbiaceæ, is conspicuous here. We also observe the beak-like tip to the nucellus which was noticed by Lyon (2) in *Euphorbia corollata* and by Schweiger (3) and Weniger (4) in other species of *Euphorbia*.

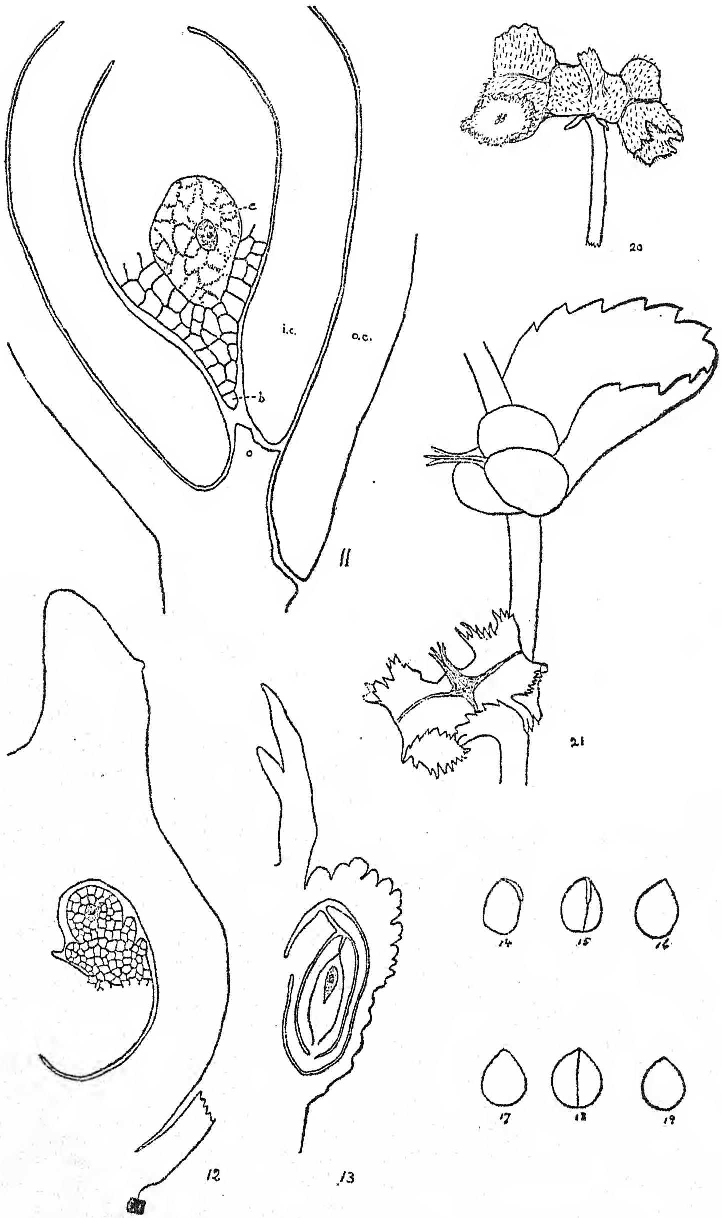
The difference in the shape of the ovary leads to interesting differences between the terminal and lateral seeds. On the lateral seeds is a conspicuous white caruncle formed by the turgescence of the outer coat and occupying mainly the space between the funiculus and the micropyle. On the terminal seed, since the funiculus almost touches the micropyle, there is almost no caruncle. On the other hand its raphe is longer, extending the entire length of the seed.

Ten seeds of each type were selected at random from five different plants and were carefully measured. Those from terminal fruits averaged 1.247 mm. long by 1.047 mm. wide, those from lateral fruits averaged 1.447 mm. long by 1.115 mm. wide. The proportion of length to width of the former lot is 1.2 : 1, that of the latter is 1.3 : 1. It is also observable that the thickness of the terminal seed is about equal to its breadth, while that of the lateral seed is considerably less than its breadth.

In the material examined two interesting sports were discovered—one being a double flower of the terminal type occupying a terminal position, and the other a similar flower occupying a lateral position and lower down than other lateral flowers of the usual type.



FIGURES 1—10.



FIGURES 11—21.

Explanation of the Figures

1. Branch of Acalypha indica *L.* × ½.

2. Single inflorescence, showing side of the terminal flower with the much-branched style on the right. × 8.

3. Terminal flower, viewed from the rear or face opposite style. × 8.

4. Mature terminal fruit, viewed from the front or style face. × 8.

5. Longitudinal section of an almost mature terminal fruit, showing the ear-like outgrowths. × 20.

6. Young staminate cyme. *C.* sepal, *s*, stamen of terminal flower. 1, lateral flower.

7, 8, 9, 10. Successive stages in development of a terminal flower. × 50.

11. Stage corresponding to 9 enlarged. *o. c.* outer coat, *i. c.*, inner coat, *o*, obturator, *b.* beak, *e.* embryo sac. × 220.

12, 13. Successive stages in development of a carpel of the lateral flower. 12 × 220, 13 × 50.

14, 15, 16. Side, front, and rear view of seed from a lateral flower. × 8.

17, 18, 19. Side, front, and rear view of seed from a terminal flower. × 8.

20. Double terminal flower. × 8.

21. Similar flower in a lateral position, an ordinary lateral flower above it. × 8.

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2. **Lyon, Florence**, Contribution to the life history of *Euphorbia corollata*. Bot. Gaz. 25 : 418-426. 1898.

3. **Schweiger, J.**, Beitrage zur Kenntis der Samenentwiklung der Euphorbiaceen. Flora 94 : 339-382. 1905.

4. **Weniger, Wanda**, Development of embryo sac and embro in *Euphorbia Preslii* and *Euphorbia splendens*. Bot. Gaz. 63 : 266-279. 1917.

THE MYXOPHYCEAE OF LAHORE.

BY

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Probably no other group of the vegetable kingdom has been so much neglected by morphologists as that of the *Myxophyceæ*. In India practically no work on them has been done at all. With the exception of a few stray records of certain Indian species by Schmidle, Hassal, Turner and West, absolutely nothing is known about the Indian Blue-green Algae.

At first sight, one would not think that the Blue-green Algae are found to any large extent in Lahore, but a little careful observation reveals a large variety of them, and in fair abundance. After the rains, that is the months of October and November, they are at their best, and then again in February and March. Even in such bad months as May and June, or December and January, they are quite easily obtainable; so that one can rightly say that the Blue-green Algae flourish fairly well in Lahore throughout the year. In this connection it might be noted that Lahore is situated in 31° 35′ N. and 74° 20′ E. Its height is 732 feet above the sea-level. The hottest months, namely May and June, have a mean maximum temperature of about 106° F., the actual highest might go up to 120° F. The coldest months, namely December and January, have a mean minimum temperature of 40° F., the lowest never going below 29° F. Rainfall is chiefly confined to the months of July, August and September, and ranges between 8 and 25 inches.

The sources of material for examination are manifold. A large number of the Blue-green Algae are found throughout the year in places, where there is a constant flow of water, such as drains and water-courses. Artificial tanks kept constantly full of water, such as those in the Shalamar and Shahadara Gardens, also form a useful permanent source. Again, after the rains, a few natural ponds and ditches are left by the road-side in the outskirts of Lahore, which take quite a long time to dry up, and are generally found to be full of algal flora. In addition to all these, short-lived varieties are found on ordinary ground or lawns, on which rain or well-water has stood for even a short time. Another interesting source is afforded by the tree-trunks, which are sometimes covered by beautiful varieties after the rain has moistened them.

SYSTEMATIC.* Of the two orders of the *Myxophyceæ*, namely the *Coccogoneæ* and the *Hormogoneæ*, the latter has been much more studied by the writer. Amongst the former, **Chroococcus turgidus** *Kuetz*, (Cooke, *l. c.* 204, pl. 83, fig. 2) is very commonly found for the most part of the year, generally sticking to the submerged walls or the floating masses of decaying vegetable matter in stagnant ponds or ditches. It is about 20μ in thickness, and is often seen to be dividing into two, or rarely into four.

Gloeocapsa polydermatica *Kuetz.*, is very common amongst the grass on lawns after a little rain or watering. It forms a thick, green layer when moist. Individual cells have a hyaline lamellose membrane, and are about 5μ thick. When dry, the stratum becomes greenish-brown, the membrane of the individual cells also taking on that colour.

Clathrocystis aeruginosa *Henf*, (De Toni, *l.c.* p. 94 ; Cooke, *l.c.* p. 212, pl. 86, fig. 7) forms a thick, green scum on stagnant water, generally where the water is full of waste organic matter such as Duck Pond in the Zoo. Fronds of various sizes and of various shapes are commonly met with at the same time. Young fronds seem to be solid, but as they grow old they become hollow, and finally clathrate.

Two or three species of *Merismopedia* are fairly common, with their families freely floating in stagnant water, or sometimes sticking to floating masses of decaying vegetable matter.

Of the second orders *Hormogoneæ* the Cohort *Psilonemateæ* is very well represented in Lahore, while the Cohort *Trichophoreæ* is as yet found to be represented only by *Rivularia bullata* Berk. Of the former, the three families, *Oscillatoriaceæ*, *Nostocaceæ* and *Scytonemaceæ* have been found to be fairly well represented, while no plant of the *Stigonemaceæ* has as yet been discovered.

Oscillatoria princeps *Vauch.* (De Toni. *l.c.* p. 150) is the thickest species of the genus yet found. It generally occurs in dirty drains, carrying off water from road-side water-pipes. Stratum dark green, first attached to the mud and then floating. Trichomes straight, rigid, yellowish-green, about 36μ thick. See Fig. 1.

Oscillatoria tenuis *Ag.* (De Toni, *l. c.* p. 166 ; Cooke, *l. c.* p. 249 ; pl. 96, fig. 8) is the commonest *Oscillatoria* of Lahore, found generally in dirty drains and in places constantly wetted, such as in mud

* The classification of the Myxophyceæ followed in this paper is taken from J. B. DeToni's 'Sylloge Algarum', Vol. V., (1907). The species have been identified from descriptions in that book or from descriptions and figures given in M. C. Cooke's British Fresh-water Algae (1882—1884). Exact references are given after each species.

round water-pipes or wells. Stratum thin, bright green. Trichomes radiating and actively oscillating, 4·8μ thick, generally a little constricted at the joints. Two varieties occur in Lahore, one with straight broad apex, and the other with curved and a little attenuated apex.

Oscillatoria terebriformis *Gom.* (De Toni, *l. c.* p. 189) is generally found forming a green scum on stagnant ponds, associated with *Clathrocystis æruginosa* and *Arthrospira Jenneri* Kuetz. Trichomes free swimming, flexible, screw-shaped or in lax spiral, with unconstricted and indistinct joints, 4-6μ thick; apex generally drawn out.

The Sub-family *Spirulineæ* is represented by **Arthrospira Jenneri** *Kuetz.* (De Toni, *l. c.* p. 206; Cooke, p. 245, pl. 96, fig. 1) which, as mentioned above, is generally found associated with *Clathrocystis æruginosa* and *Oscillatoria terebriformis.* Trichomes bright green, elongated, 4·6μ thick. Spirals 10-16μ in diameter, and about 8μ distant. Joints distinctly constricted; cells globose.

Of the Sub-family *Lyngbyeæ, Phormidium* is more frequent than *Lyngbya.* **Phormidium ladinianum** *Gom.* (De Toni, *l c.* p. 218) has been found on tree trunks, especially on that of *Acacia modesta*, associated with *Phormidium Hansgirgi* Schm. and *Tolypothrix byssoidea* Krichn. Stratum dark green, thin, fibrous. Trichomes straight, flexible, constricted at the joints, 4-6μ thick. Sheath thin, hyaline. Contents granulose, sometimes hyaline in the centre. See Fig. 3.

Phormidium tenue *Gom.* (De Toni, *l.c.* p. 227) generally sticks to the submerged walls of artificial tanks, forming a membranous-expanded, dirty green stratum on the mud. Trichomes long, a little curved and densely intricate, slightly constricted at the joints, 1-2μ thick.

Phormidium Hansgirgi *Schm.* (De Toni, *l. c.* p. 235) is found on tree trunks, associated with *Tolypothrix byssoidea* and *Phormidium ladinianum*, forming a dark bluish-green stratum. Trichomes parallel, 10-12μ thick, with broad convex apex. Sheath hyaline when moist, and dirty brown and fragile when dry. See Fig 4.

Phormidium Moerlianum *Grun.* (De Toni, *l.c.* p. 236) is found in stagnant water, where decaying vegetable matter is present. It is generally associated with a species of *Oedogonium.* Trichomes long, a little curved, brownish, 9-12μ thick; joints very short. Sheath thin, colourless. Dissepiments granulated. See Fig. 5.

Lyngbya aestuarii *Lieb.* (De Toni, *l.c.* p. 262; Cooke, *l.c.* p. 258 pl. 101 fig. 1) is commonly met with, associated with a species of *Oedogonium*, and forming freely floating greenish masses. Trichomes long, flexuous, blue-green, granular, about 40μ thick; joints very short. Sheath hyaline, clearly lamellose and brownish when old,

The Sub-family *Schizotricheæ* is represented by **Microcoleus vaginatus** *Gom.* (De Toni, p. 374; Cooke, p. 258, pl. 99, fig. 2, under *M. terrestris Deson*) which lives commonly on damp mud, such as that in lawns, flower-pots, and around ponds and ditches. Trichomes long, collected in filiform, tortuous fascicles, enclosed in a common mucous sheath, from the apex of which they come out in a penicillate manner. Dissepiments granulated, fascicles 75-80μ thick; trichomes 4-5μ thick.

The family *Nostocaceæ* is represented by **Nostoc commune** *Vauch.* (De Toni, *l. c.* p. 404; Cooke, *l. c.* p. 231, pl, 91, figs. 4-7) and *Cylindrospermum majus* Kuetz. The former is found in large abundance in damp soil, even on lawns after a little rain or watering. Colonies are at first globose and resemble *Botrydium*, then they expand and become more or less irregular, but still keeping the outer membrane intact. Trichomes flexuous, loosely intricate; joints spherical, uniform about 5μ thick. Heterocysts globose, 7μ thick.

Cylindrospermum majus *Kuetz.* (De Toni, *l.c.* p. 424) is occasionally met with forming a bluish-green, thin expanded stratum on damp mud. Trichomes 4-5μ thick. Heterocysts oblong, 6-8μ thick. Spore cylindrical, 10μ wide, 20-15μ long.

From the Sub-family *Scytonemaceæ*, three species of *Tolypothrix* are commonly met with in Lahore. **Tolypothrix distorta** *Kuetz.* (De Toni, p. 541; Cooke, p. 268, pl. 108, fig. 2) is very abundant in stagnant or very slowly running water, such as the broad water-courses of the Shalamar Gardens. It generally forms a very much expanded blush-green stratum on broad floating, half-decayed leaves, such as those of the water lily. Trichomes and pseudo-branches loosely interwoven, 8–11μ thick; joints sometimes indistinct. Sheath membranous, thin, sometimes inflated at the base of the branch, hyaline, yellowish-brown when old. Heterocysts 8-9μ thick, and 12–14μ long.

Tolypothriz byssoidea *Kirchn.* (De Toni, b.c. p. 551) forms a dark brownish stratum on the trunks of trees such as those of *Acacia modesta*, and is generally associated with *Phormidium ladinianum* and *Phormidium Hansgirgi*. Trichomes 9–11μ thick, with irregular pseudo-branches, torulose. Sheath thin, yellow or brown, fragile, tubular. Heterocysts oblong, about 16μ long.

Tolypothrix arenophila *West* (De Toni, *l.c.* p. 554) lives on damp coarse mud, such as that in lawns or around ponds and ditches. At first it forms small circular bluish-green, shiny patches, which expand later on. By coalition of several such patches a very extensive stratum is produced. Trichomes flexuous and contorted, densely intricate, about 6μ thick, with few pseudo-branches. Sheath thick,

yellowish-brown, firm, lamellose when old. Contents granulose, refringent. Heterocyst oblongo-rectangular, about 10μ long.

As mentioned above, of the Cohort *Trichophoreæ*, in Lahore only **Rivularia bullata** *Berk.* (De Toni, *l c.* p. 660) has been found as yet. It forms hemispherical, lobed, gelatinous fronds on damp soil by the river-side. Trichomes 6-8μ thick, bluish-green, a little constricted at the joints, thinned out into a hyaline point at the apex. Heterocyst globose, $6{\cdot}8\mu$ thick. See Fig. 6.

PERENNATIONS. In this connection, a few observations might very well be recorded. Terrestrial forms, such as *Gleocapsa majus*, *Nostoc commune*, *Phormidium Hansgirgi*, *Tolypothrix byssoidea*, *Tolypothrix arenophila*, generally tide over the unfavourable time by enclosing themselves in their sheaths, which often become much thicker and sometimes lamellose, and take on a yellowish-brown colour. On the return of favourable conditions they come out of the sheath, and multiply.

Resting spores have been very clearly seen in *Tolypothrix distorta* in all the stages of development. Generally a number of cells, about four, fuse together by the absorption of the intervening cell-walls and swell up. The contents take on a separate wall, which becomes firm and yellowish-brown. Many spores are formed in a chain-like series. They are oblong in shape, and 18-21μ by 11-13μ in size. Germination of these spores has not been observed as yet. See Fig. 7.

CONCLUSION. The species of the Blue green Algae, described above, occur quite commonly in Lahore, but in addition to these, there are a few others, which are met with only occasionally; and for that reason have not been yet identified or studied properly.

Explanation of Plate III.

Fig. 1. A small portion of *Oscillatoria princeps*. ($\times 500$).

Fig. 2. A filament of *Oscillatoria terebriformis*. ($\times 1000$).

Fig. 3. A portion of *Phormidium ladinianum*. ($\times 600$).

Fig. 4. A portion of *Phormidium Hansgirgi*. ($\times 666$).

Fig. 5. A portion of *Phormidium Moerlianum*. ($\times 666$).

Fig. 6. Two filaments of *Rivularia bullata*. ($\times 1000$).

Fig. 7. A portion of a filament of *Tolypothrix distorta*, forming resting spores. ($\times 500$).

Fig. 1.

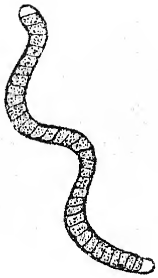

Fig. 2.

Fig. 3.

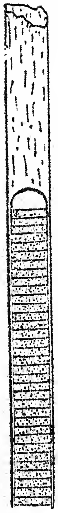

Fig 4

Fig 5.

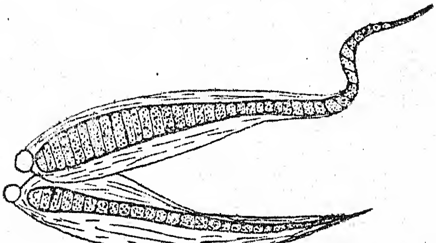

Fig. 6

Fig 7.

ON ALYSICARPUS RUGOSUS *D. C.* AND ITS ALLIED SPECIES.

BY

L. J. SEDGWICK, F.L.S.

It is a well-known crux whether the extremely diverse forms of *Alysicarpus* which show a lomentum with the joints deeply and closely transversely rugose belong to one species or several. De Candolle (Prodr. I, 353) described two species,—*A. styracifolius* and *A. rugosus.* Wight and Arnott (Prodr. I, 234) gave three, *viz.*, *A. styracifolius* of De Candolle, and two new ones of their own,—*A. Wallichii* and *A. Heyneanus.* Baker (F. B. I. II, 159) reduced all previous descriptions and all known specimens to one variable species, for which he retained the name *A. rugosus* D.C., making *A. styracifolius* D.C. and *A. Heyneanus* Wt. & Arn. varieties, along with a third variety *ludens* from the specific *A. ludens* of Wallich, and regarding Wight and Arnott's *A. Wallichii* as a synonym of the type. Later floras (so far as known to me) have followed Baker, several other varietal names, however, having been added, *viz.*, *minor* and *pilifer* both of Prain, and probably others.

While not denying that many of our Indian species need reduction, being merely local or edaphic forms, I am disposed to think that the Indian Floras have often on the other hand given a wholly exaggerated impression of morphological variability (as opposed to plastic reaction to environment) through failure to detect the definite characters dividing closely allied species; and this would seem to be the prevalent view at the present time. In particular I am convinced that where in the same habitat two clearly distinguishable forms exist side by side and do not merge they must necessarily be true species. For this reason the field worker is an indispensable complement to the herbarium systematist, inasmuch as he is able to observe the innumerable plants around him, and note their demeanour.

The fact that *A. rugosus* D. C., as understood since the F. B. I., contains more than one species has been forced upon me by field observations at various camps in the Dharwar District during the last three seasons. For instance this winter on the black soil east of Hubli, M. S. M. Ry., two quite distinct plants were abundant as weeds in the fields. Their differences amounted to at least six characters.

Over a wide tract of country there must have been millions of these plants, and out of the enormous number which came under observation during a month and more no individuals were seen which could not be at once allocated (even from horse-back) to one or other of the two types. Now if these types were intra-specific, then their contrasting characters would be allelomorphs. I regret that it did not at the time occur to me to observe the methods of fertilisation; but there is reason to expect that a typical papilionaceous flower with diadelphous stamens is liable to cross-fertilisation. If so, and if the contrasting characters were allelomorphs, then the occurrence of two separate types each of them exhibiting the whole set of contrasting characters, without the occurrence of even one individual which could be classed as heterozygotic in even one pair of characters, would, I suppose, be an impossibility. However, even if *Alysicarpus* were shown always to be self-fertilised, still the absolute constancy and uniformity of these two sets of characters in the same environment would, I fancy, have convinced anyone who had seen them that we have here two species.

In a single homogeneous tract like the black soil referred to the habit of a species is likely to remain fairly constant. But there is little doubt that most of the species of *Alysicarpus* are highly plastic and react strongly to environment; and this plasticity is probably the main cause of the confusion which now exists as regards the species with the rugose lomentum, since the superficial (somatic) differences between individuals of the same species are often more obvious than the morphological (germinal) differences between the species.

The systematic notes which follow are based on the field observations referred to as well as on the material in the herbarium of Mr. T. R. D. Bell, C.I.E., and myself, and the material in the herbarium of the St. Xavier's College, Bombay, collected by Father Blatter and Mr. Hallberg, and very kindly placed at my disposal by those gentlemen. This material is all from Western India at various points from Mt. Abu to Madura. It will be seen that I discriminate three certain and one probable species. But I should be far from suggesting that a study of material from the whole of India would not necessitate the recognition of further species. This paper is intended to be suggestive only, and is published in the hope that other workers may find it of use in a further and more complete study of this particular systematic problem. Especially has it been quite out of the question to attempt the unravelling of the intricate synonymy of these plants; indeed it is doubtful whether this work could be done anywhere but in Europe, where alone the numerous type sheets may still be available.

1. A. styracifolius *D.C.*

Prostrate, or with geniculately ascending branches, (possibly sometimes erect ?). All parts covered both with short pubescence and longer stiff opaque white hairs. General colour of the leaves dark leaden-green, contrasting strongly with the pale racemes. Racemes short, dense. Calyx paler than straw-colour; segments ovate acuminate, usually with an indurated tip, closely ciliate throughout their length with straight erect white hairs. Lomentum usually exserted.

HERB. SEDGWICK AND BELL.

No.		
1801	Coimbatore	Aug. 1916
2010	Black soil fields, Kunemelihalli, Dharwar Dist.	Dec. 1916
5274	5278, 5281, 5283 to 5289. Black soil fields, east of Hubli	Feb. 1919
5308	5336. Fields, Sherewad Dharwar District ...	Do.
5697	Gokak, Belgaum District	March 1919

HERB. ST. XAVIER COLLEGE, BOMBAY.

631	Kamban, Madura District	May 1917
8843	Tapti R Banks, Khandesh	Dec. 1916
8855	Dangri, Khandesh	Do.
8788	Khandesh	Do.
10086	Muravad, Khandesh	Do.
12385, 12394, 12395	Bhusaval, Khandesh ...	Do.

This species seems to be much less variable than the others. It is usually fairly easy to pick out in herbaria from the strong contrast between the dark leaves and pale racemes.

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2. A. Heyneanus *Wt. & Arn.*

Usually erect, rarely procumbent with geniculately ascending branches often very tall and robust. Stem clothed all over with pubescence and spreading hairs. General colour of leaves ordinary green. Racemes variable in length and density, but usually long lax and narrow. Calyx straw-coloured; segments oblong subacute, with a few white hairs or not. Lomentum usually prominent exerted.

HERB, SEDGWICK AND BELL.

No.		
2034.	Yelvigi, dry regions of the Dharwar District,	Dec. 1916.
2087.	Kunemelihalli, Dharwar District, on black soil,	do.
3675.	Forty miles south of Dharwar,	Feb. 1918.
3840.	Chabbi, Dharwar District,	do.
5269, 5270, 5272 to 5277, 5279, 5282.	Black soil fields, east of Hubli,	Feb. 1919.
5313 to 5315, 5337.	Fields, Sherewad, Dharwar District,	do.
5441.	Dangs, Gujarat (very robust),	do.
5486.	Tegur, Dharwar District (very robust),	March 1919.

HERB. ST. XAVIER COLLEGE, BOMBAY.

10195.	Taver, Khandesh,	Dec. 1916.
22684.	Antorli, Khandesh,	do.
8813. 8814.	Tapti R. Khandesh,	do.
8787.	Antorli, Khandesh,	do.
10102.	Paldhi, Khandesh,	do.
8853.	Khandesh,	do.
8852.	Tapti R. Khandesh,	do.
8844.	Muraval, Khandesh,	do.
9376.	Lina Hill, Nasik,	Sep. 1917.
8784.	Bombay Island, (short, but with v. lax racemes),	Nov. 1916.
8786.	Igatpuri, Western Ghats, (a form similar to the last),	Jan 1917.
8805.	Igatpuri, (tall and with v. lax racemes),	do.
12849.	Turanmal, Satpuras, Khandesh, (an old state, very robust *very* long racemes).	Dec. 1918.

This species is highly variable in habit.

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3. A. rugosus *D.C.*

Usually prostrate, but sometimes erect. Stem glabrous except for a single alternating line of oppressed ascending hairs. General colour of leaves ordinary green. Racemes short dense. Calyx straw-coloured; segments long, oblong, subobtuse, glabrous, or ciliate at the tip only with short, often purplish hairs. Lomentum usually inclined.

HERB. SEDGWICK AND BELL.

1846.	Mugad, Dharwar District,	Oct. 1916.
2155.	Dharwar,	Nov. 1916.
4366.	Dharwar,	Sept. 1918.
4438.	Konankeri, Dharwar District,	Oct. 1918.

HERB. ST. XAVIER COLLEGE, BOMBAY.

No.		
12858 and 12827.	Sea-shore, Alibag, Konkan (Coll. by Moses Ezekiel).	Feb. 1917.
12862.	Rice-fields, Alibag, (Coll. as the last),	do.
8798.	Salsette, Bombay,	Nov. 1918.
8778, 8774 and 9383,	Mt. Abu,	Oct. 1916.
8848.	Bombay,	Nov. 1916.
8834.	Salsette, Bombay,	Sept. 1916.
8803.	Purandar Fort, Poona District,	Dec. 1917
12829.	Poona,	
9370.	Bassein, North Konjan (tall),	Sept. 1918.
9385.	Bassein, (tall, but with short racemes),	Sept. 1917.
12686 and 12688.	Campoli, (v. tall, with racemes 2 inches long),	Oct. 1918.

4. A. ludens *Wall.* (*probably*).

Tall, erect. Stems with line of hairs as the last. General colour of leaves ordinary green. Racemes exceedingly long and lax, with distant flowers in pedicellate clusters.

HERB. ST. XAVIER COLLEGE, BOMBAY.

No. 12691. Khandala, October, 1918.

A working clavis would be as follows :—

Stems pubescent and with spreading hairs,

Leaves dark leaden-green, racemes dense, calyx segments acuminate, strongly ciliate . . . . A. styracifolius *DC.*

Leaves ordinary green, racemes lax, narrow, calyx segments subacute, with or without a few hairs . . A. heyneanus W. & A.

Stems glabrous except for an alternating line of oppressed ascending hairs,

Racemes short, dense . . . . A. rugosus, *DC.*

Racemes very elongate, lax, with distant fasicles of pedicellate flowers . . . . A. ludens *Wall.*

It is necessary however to remark that with age both the vestiture of the first two species and the line of hairs of the last two are deciduous.

NOTE ON THE OECOLOGY OF SPINIFEX SQUARROSUS *L.**

BY P. F. FYSON, B.A., F.L.S., AND M. BALASUBRAHMANYAM, B.A.

The question discussed in this paper arose in the course of an investigation into the water and soil-relations of the marine strand vegetation of Madras. One of the most important species of the strand formation is *Spinifex squarrosus* L. It occurs on low sand-dunes as close as 20 yards only from the sea, but always raised a few feet above high-tide level. It usually grows by itself, but in open patches *Cyperus arenarius* Retz. and *Launæa pinnatifida* Cass. sometimes occur.

The plant spreads over the sand by horizontal shoots which root at the nodes, usually beginning with the second and third node from the growing end. The adventitious roots are thick and run more or less vertically downwards for one or two feet, with only small rootlets. Root-hairs are conspicuously developed on the oldest part near the surface of the soil and seem to be persistent there. A few inches below the surface of the ground there are usually none, or only shrivelled dead hairs, and the root is sometimes thinner because of the exfoliation of the outermost layers of the cortex after the formation of an exodermis. The youngest part has no root-hairs, as a rule; the root being quite smooth for one or two inches behind the tip, then becoming slightly lumpy on account of branch roots pushing out from below, but still without any sign of root-hairs.

If a plant be dug up without breaking the roots, and grown in a jar with some roots in water, root-hairs appear on young roots close behind the growing point, but not on older roots.

Sections of this lowest region shows the root surrounded by a highly refractive substance, which is apparently secreted by the cells of the piliferous layer. This layer and its secretion can be traced quite easily under the root-cap back to the earliest stage in the differentiation of root-cap and piliferous layer. The cells are at first isodiametric but soon become elongated radially, taking on the general appearance of secretory tissue. There are no intercellular spaces, the cells are narrow the protoplasm is dense without vacuoles and the nucleus large and situated about the middle. The outer wall is irregular in outline, and beyond it the secretion is marked by tangential

* Paper read at the Indian Science Congress, 1919.

and also by radial lines, which latter appear to be continuations of the middle lamellas between the cells, (fig. 3.) The tangential lines are clearly due to stratification of the substance produced by successive changes in its composition affecting its refractive index, for they are progressively further apart and fainter, and the presence of the radial lines clearly indicating the lateral limits of each cell, shows that the secretion or modification of each cell takes place independently of those of contiguous cells.

The secretion does not take up any of the ordinary protoplasmic stains, such as eosin, osmic acid, or hæmatoxylon; nor could we obtain any reaction with methyline-blue, Schultz solution or iodine.

We conclude that the secretion is due to a modification of the cell-wall, and though controlled and brought about by each cell independently, is not a direct product of its protoplasm. But that it is not a gum or mucilage in the ordinary sense is shown by the fact that it does not swell and dissolve in water at the ordinary temperature, nor take up any cellular stains nor show any cellulose reaction.

The Root-hairs.

As stated above, the root-hairs are found only on parts of the root near the surface of the sand. A few inches down they are cut off by the exodermis, which is formed as usual in monocotyledons, and shrivel up. But near the surface there is no exodermis, and the root-hairs formed while that part was still young persist apparently indefinitely.

The Regions of the root.

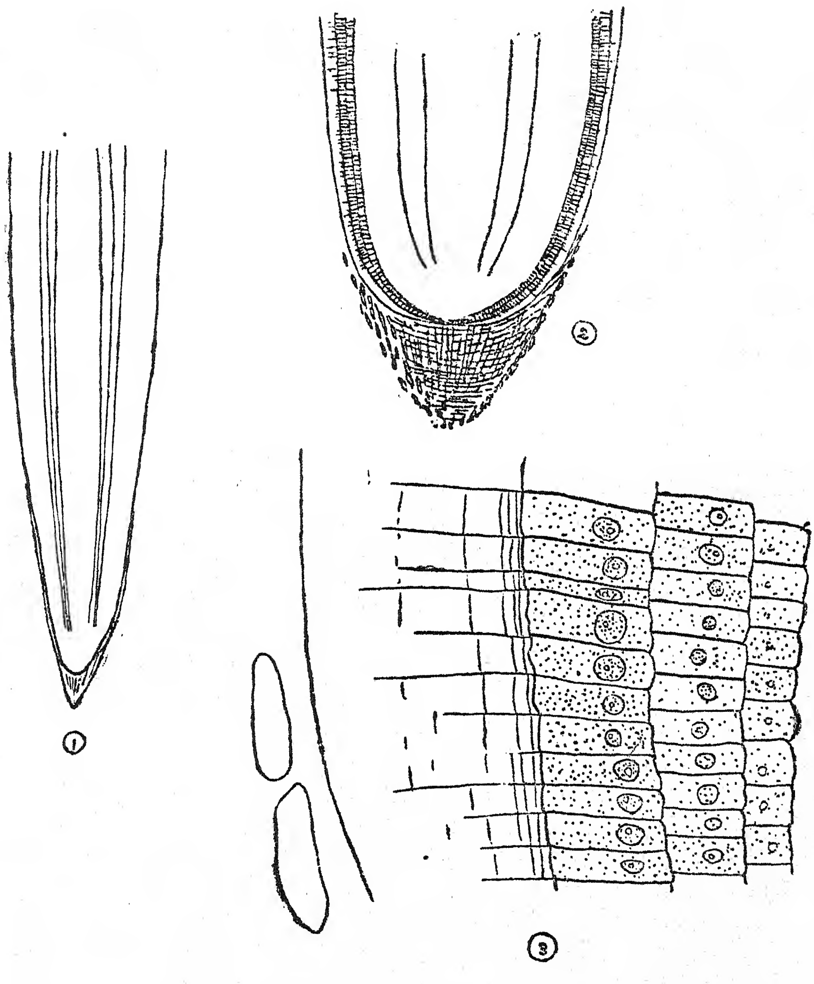
There are three regions in the root :—

I. From the tip to the region of the exodermis the surface is covered by the secretion. This may be two to six inches long and the surface is white, smooth and glistening.

II. In the region of the exodermis the surface tissue is dead and brown. It is in this region that the short rootlets are found.

III. From the exodermal region to the surface, for a length of two or three inches as a rule, the piliferous layer remains fresh, the root-hairs persist and adhere firmly to grains of sand.

The existence of a secretion by the piliferous layer has been noted, we believe, in only a few grasses, which grow in the Algerian Sahara. The chief of these is *Aristida pungens*. R. Price (2) who has examined the secretion, pointed out that in *Aristida* it binds together the sand particles with a tubular sheath into which root-hairs run and are thus enabled, probably, to take up moisture from a larger volume of sand.



1. Longitudinal section of root. 2. Longitudinal section of the tip magnified showing the layer of secretion. 3. Small part of some magnified showing to he left two loose cells II of the rootcap. The secretion shows striation tangentially and radially.

With *Spinifex squarrosus* no tubular sheath is formed, for the secretion does not cause the sand particles to adhere. It appears to act rather as a lubricant or perhaps as a resisting layer to protect the piliferous layer from damage by sharp grains of sand. Spinifex is not related closely to any of the grasses noted by Price as possessing the mucilage layer. The genus consists of only four species, occurring on sandy shores of India, Malaya and N. Australia.

The Water-supply.

Every one knows that sand a very few inches below the surface is damp, as also is any ordinary soil. With ordinary clay or loamy soil this is usually taken to be due to an upward movement from low levels of water drawn up by capillarity through the fine cracks developed by the drying of the soil. This water being continually dried at the surface of the ground. There may be a slow upward movement of water also through sand; but it is very slow. This was determined by us both in the laboratory and in the sand of the beach. In the laboratory two wide glass tubes were filled with dry sand, the lower end closed with muslin and the tubes supported with their lower ends, one in fresh water, the other in salt water. At first the rise of water as shown by the darkening in colour of the sand was rapid, but after the first day the rate fell off and after seven days the level was practically stationary at 24 cms: a slow rise went on for everal days till it reached 30 cms. Then no further rise was noted. There was no appreciable difference between the two tubes. The experiment was continued for 4½ months without any change in the level of the dampness being seen. It came to an end with the rotting of the muslin holding in the sand.

In another series of experiments 8-inch drain pipes were sunk in sand in an enclosed space but open to the air. The pipes were 36 inches long. They were filled with dry sand, and some left open, others closed at the top. No appreciable rise of water could be detected after periods of three to six weeks except in one case where the sand had a musty smell and was slightly more damp below than above, pointing to a rise of water from below. Heavy rain had fallen and the sand outside had been saturated, so that the water might have come up as much by hydrostatic pressure as by capillarity.*

* The use of pipes in this way has been objected to by Olsson-Seffer (1) on the ground that no lateral movement of the air enclosed in the pipe is possible as would, he considers, occur in nature, and that the free movement of the water would be prejudiced thereby. But a little consideration would show that in a homogeneous medium of practically limitless extent (as the sands of the seashore) there can be no balance of lateral air-movement inwards or outwards from any imagined volume, and that it is therefore per-

Other workers have observed the same thing, that water does not rise by capillarity in sand; the explanation probably being that there are no capillary tubes formed as in a fine grained clay. The dampness of the sand just below the surface is then not due to a rise from below.

The only other source of water is from above, as rain or dew; and it seems clear that the water in sand even by the sea is not salt water drawn up from below nor even brackish but quite fresh rain water, preserved by the inability of the sand to draw it up to the surface when it would quickly be dried by the sun.

To test this point, we dug pits in the sand till free water was obtained, the depth varied from 2 to 6 feet. The salt in the water was estimated by standard silver nitrate solution. Samples were taken from different parts of the beach with the following results :—

Plant growing.	Salt.
Cyperus arenareus	0·2—0·5 per cent.
Do. with Launæa pinnatifida ...	0·25 ,,
Hydrophylax maritima	0·35 ,,
Spinifex squarrosus	0·85 ,,
(No plants) near sea	6·3 ,,

It will be seen that except on the narrow strip which is periodically inundated by the sea, the salt-content is very low. It should be noted that the water obtained at, say, 3 feet is not all water which has sunk down from above but some naturally free at that depth. The sinking is clearly seen when the pit is dug. It seems therefore that *Spinifex squarrosus* and other strand-formation species are not halophytes at all as suggested by Schimper (3) Warming at one time, (4) and others, but rather xerophytic psammophytes, depending for their water-supply on the rain-water and dew retained by the sand. The former, it may be noted, though it sinks through the surface layers almost or quickly as it falls, would not pass through the lower layers quickly, for the sand on these low beaches must be saturated at no great depth by the sea-water which has filtered through. As regards dew we have noticed, during the hot weather, in the early morning before sunrise, distinct deposits of dew on the seaword face of every little lump of sand, *e.g.*, the sides of a foot-print and round plants, as if deposited when a slow moving moisture-laden breeze passing over the cooling sand was delayed by the small obstruction. The accumulated effect of this dew, slight as it is, would keep the sand below the surface damp and supply fresh water to plants whose root-hairs are near the surface.

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fectly justifiable to draw conclusions from experiments with definite volumes enclosed in non-porous pipes.

Nor are strand-plants however ordinary xerophytic psammophytes. Psammophytes are as a rule deep rooted, and draw on deep-lying water for their supply. These strand-plants do not. Their root do not grow deep, and in Spinifex at least the root-hairs are, as we have seen, close to the surface and depend apparently on water close to the surface of the ground. This water would, we have seen, be fresh. A certain amount of salt must be blown in from the sea as spray and this would be leached though the surface layers by the next shower of rain down to a certain depth. Perhaps this accounts for the formation of an exodermis and the absence of root-hairs on the lower roots of *Spinifex squarrosus.*

Finally there is another condition different from that of either a desert or sand-field. The air blown across from the sea is damp. It is never dry by the sea, except when the land breeze blows strongly. It is damp close to the water. The strand-plants therefore are xerophytic in the sense of having to depend on very little fresh water, but in regard to the water lost by evaporation from the leaves have much less to fear than even mesophytic inland plants. They are surrounded by air as damp as that round a lake. They are not halophytes. They are not xerophytes in the ordinary sense, but subject to the peculiar condition of a shortage of water available to the roots, yet without liability to extensive loss from the leaves. Perhaps their chief physiological characteristic is therefore the ability to carry on metabolism with a minimum of water passing through the system.

As regards the xerophytism of strand-plants, Kearney (5) came to similar conclusion after analysis of the salt-content of the soil. He found that seashore sand and contains less salt than some cultivated soils. Kearney insists on the xerophytic character of plants as being due to dry winds and dry sand. But a distinctly moist air seems in Madras to be the rule near the sea.

Literature Cited.

(1) *Olsson-Seffer.* New Phytologist VIII (1909) p. 38.
(2) *Price, R.* New Phytologist X (1911), p. 328 *et seq.*
(3) *Schimper, A. F. W.* S. B. K. Preuss, Akad, Wiss., 1890, pp. 1045–1062 extr. in J. R. M. S. 1891, p. 214.
Plant Geography, p. 184.
(4) *Warming, E.* Œcology—Eng. Ed. (1909), p. 227.
(5) *Kearney, T. H.* Bot. Gazette, XXXVII (1904), p. 424.

CURRENT LITERATURE.

Critical Notes, Figures, new Indian Species, etc.

Trichodesma indicum *Br.* and **T. amplexicaule** *DC.* In a note in *Rec. Bot. Survey India VI (1919) p. 347*, L. J. SEDGWICK points out that these two species, often confused, are really quite distinct, there being differences in habit, in the leaves, in the calyx, corolla, stamens and fruit. Confusion has been due to Roth describing as T. amplexicaule what is really a form of *T. indicum* Br. The chief differences are illustrated in a plate, and the paper is a good example of what can be done in clearing up mixed species by careful observation, even without recourse to type sheets.

Fumaria indica *H. W. Pugsley* Sp. Nov. *Proc. Linn. Soc. XLIV (1918)* No. 298, p. 313, hitherto included in *F. parviflora* sub-sp. *Vaillantii* in F. B. I. 128 (1872).

Impatiens Kleiniformis *L. J. Sedgwick* Sp. Nov. *Records of Bot. Sur. India, VI (1919) p. 351.* Very close to *I. Kleinii* Wt. and Arn., but distinguished by the lines of pubescence on the pedicels, the sessile upper leaves with cordate base, and the absence of glands. *Dist.* Western Ghats at 1,600 feet, Castle Rock. Flr. August.

Vernonia Fysoni *Calder*, Sp. Nov. *Rec. Bot. Sur. India. VI (1919) p. 343* (with plate). Allied to *V. Wightiana* Arn. and *V. comoriensis* W. W. Smith, but distinguished by the glabrous obtuse involucral-bracts, glandular 10-ribbed achenes, and the absence of outer series of pappus hairs. A tall subscandent undershrub with dark upper and very white tomentose under surface to the leaves. *Dist.* In light sholas at Kodaikanal, Pulney Hills 7,000 feet.

Habenaria (§ Ate) **multicaudata**. *L. J. Sedgwick.* Sp. Nov. *Rec. Bot. Sur. India VI (1919) p. 352.* 'A distinct and curious species strongly characterised by the fantastic filiform appendages and enormous anther cells, projecting beyond the flower when it is held in profile. *Dist.* North Kanara, near Karwar at 1,500 feet. Flr. Sept.

Asparagus Fysoni *MacBride*, Nom. Nov. *Contr. Gray Herb. Harvard Univ. (1918) p 17*, for the Nilgiri and Palni plant hitherto known as *A. subulatus* Steud. et Baker (1875), which specific name had been given previously to a S. African plant by Thunberg, *Prod. Pl. Cap. 66 (1794)*.

Primula chasmophila *Balf.* (from Bhutan) is figured in *Curt. Bot. Mag. t. 8791 (1919)*.

Primula tibetica *Watt.* (Sikkim and Bhutan) is figured in *Curt. Bot. Mag. t. 8796*.

Ipomoea dasysperma *Jacq.* (Simla, Rohilcund and Deccan) is figured in *Curt. Bot. Mag. t. 8788.*

P. F. F.

The Genus Oxalis in India.

C. C. Calder. The Species of Oxalis now wild in India. *Rec. Bot. Sur. Ind. VI. (1919) pp. 326—341 with 7 pl.*

Of the nine species now well established four are tropical American, two

South African, one North Temperate, one Himalayan, and the last Cosmopolitan. Three of the species, *O. variabilis* Jacq., *O. pes-capræ L.* and *O. pubescens* H. B. & K., are reported in India only from the Nilgiri and Pulney Hills; *O. tetraphylla* occurs there, but also in Assam; *O. latifolia* H. B. & K. and *O. corymbosa* DC., both in S. India and on the Himalayas, two others *O. Acetosella* L. and *O. Griffithii* Edgew. and Hook f., belong in India to Assam, Khasia and the Himalayas. *O. corniculata* L. is widely distributed. An artificial key is provided to facilitate the recognition of the species and there are 7 excellent full-page plates. The paper is a record of the occurrence of these weeds in India, which will probably be of very great interest in years to come, when considering how much some of these species have spread to the annoyance of planter and gardener alike, it is probable that the distribution of some at least will be much more general.

P. F. F.

Flora of New Guinea.

Ridley, H. N. The Botany of the Wollaston Expedition to Dutch New Guinea, *1912-13. Trans. Linn. Soc. 2nd, Ser. IX. I pp. 1—269 and 6 pl.*

This the second expedition organised by Mr. A. F. R. Wollaston to New Guinea, was to the Nassau range drained by the Utakwa river. The country traversed was of the wildest description, and in the absence of maps and names the various camps have to be indicated by numbers. The route followed was for some 28 miles up the Utakwa river or its tributary, then over much broken limestone, along ridges sometimes only 4 to 5 feet wide, or descending over a thousand feet to cross some stream. The nature of the going may be guessed from the simple statement that as much as six miles were done in the earlier marches, but later they shortened to little more than two. Oaks occurred at 6,000 ft., and mixed forest densely clothed with moss and reeking with moisture, and at about the same height a large fruited Pandanus. At 8,000 ft. Casuarinas draped with moss were the dominant feature of the vegetation. The limit of trees was reached at 10,900 ft., above which the rock was too steep to support large growths, and just below the snow line the last flower met with was a daisy (Myriactis).

Mr. Ridley divides the country botanically into four regions: (1) the coast region, up to 500 ft., where the forest is swampy and dense and the flora mostly Malayan. (2) the foothill area, from 600 to 3,000 ft. (on light coloured limestone, coral rock or gravel), where the flora is chiefly Malayan. Here occurred the Anonaceæ, Garcinias, Olacineæ, and Icacineæ (except one species of Gomphandra) *Gardenia, Ixora, Webera, Dioscorea, Saccolabium* and *Burmannia* to mention only a few of the genera. A flora which reminds us of that of the uppermost slopes of the mountains of South India at 5—6,000 ft. (3) The frontal mountain zone, to 8,000 ft. and more, with palearctic forms mixing with the Malayan, *e. g. Viola, Oenanthe, Hypericum, Evodia, Ischœmum, and Dodonea.* (4) The main range where, from 6,500 to 8,000 ft., Casuarina trees and Violets were the most noticeable features. In the open country were Orchids, *Myriactis, Anaphalis, Astibe* and *Rhododendrons.* Between 9,000 and 11,000 ft., bushy Vacciniums and Rhododendrons formed a bushy jungle densely overgrown with mosses and very difficult to traverse. At 10,500 grew the curious Pine-like *Podocarpus papuanus,* but above the rocks were so steep that but

few plants can grow. Rhododendrons grew however to 13,000 ft. Among the plants of this region were species of *Achronychia*, *Pilea*, *Elatostema*, *Rubus Impatiens*, *Symplocos*, *Habenaria*, *Ilex*, all of which genera occur on our South Indian mountains at much lower levels. The flora falls into thee groups, an Australian, an Antarctic and a Palaearctic.

Over 500 new species are described, and it is considered that New Guinea with its adjacent islands should be considered a "distinct region of its own with a large endemic flora revised with derivatives from Malaya, Australia, and Poylynesia, and possibly through the Philippines, from the temperate regions of the North."

P. F. F.

Ecology.

McLean, R. C. Studies in the Ecology of Tropical Rain Forest. *Journal of Ecology VII. (1919) pp. 5—59.*

This very interesting paper is the first of a series on the ecology of the tropical Rain forest (as developed near Rio de Janeiro). It is a record of careful work and full of suggestive ideas. Records were taken by self-recording instruments of the humidity inside and outside the forest, the former at both a low-level of 1 metre, and a high level of 4 metres, above the ground. The low-level instrument as might be expected showed much smaller range of variation than the high, and at the latter level the humidity was greater on the whole but much more variable than that in the city of Rio. The incessant variations in humidity the author puts down to the effect of flecks of sunlight piercing the canopy of leaves, and he considers that these variations have a marked effect on the ecology of the under-growth. Elaborate calculations and measurements of the diffusion capacity of the stomata, the volume of inter-cellular spaces in the mesophyll, and the area of cross section of the xylem portion of the vascular bundles of the petiole, in shade and in sun plants, are given, and show that in these plants of the under-growth capacities for absorption and conduction of soil-water are developed only on a low scale.

They possess no adaption towards increasing the amount of transpiration, but are commonly protected by a thick cuticle. This may be explained as due to the frequent short periods of insolation by sun-flecks which by lowering the humidity, in conjunction with the fact that the chlorophyll in shade leaves is more exposed to the influence than in habitual heliophytes, may cause the loss of water to be greater than the roots can supply. This failure to obtain more water from the soil "seems to point to edaphic factors antagonistic to absortion." The author goes on to say that a shortage of mineral matter might be expected, but examination shows that there is a higher content of ash in relation to the weight of assimilates than in heliophytes; so that the absorbtion of mineral salts appears to be independent of foliar evaporation. In othes words the roots exercise a selective action. This of course is no new idea. Among other interesting points touched on is the effect of a nyctitropic position on transpiration, where the author finds to be negligible, and to have no significance in regard to water-loss. He thinks that the vertical position may prevent the closing of the stomata by too rapid transpiration during the early sunshine hours when assimilation should be active. Another is the large amount of moisture transpired

by the red leaf of *Acalypha* as compared with another sun-plant—*Passiflora*—and from this he is led to consider (somewhat inconsequently perhaps since the *Acalypha* was a sun plant) that a red coloration of the leaves of the undergrowth may possess the same biological significance as that of Red Algæ—to enable us to be made of the green light which filters through the leaves of forest. A third observation worth noting is that the so-called drip-trip, which as developed in this forest he considers has not the significance ascribed to it by Stahl in Java, the nature of the surface saving more effect on drinage than this shape of the leaf. In this connection reference may be directed to a paper by L. S. Sedgwick who offers an explanation of the existence of acuminate apices, in the 'Indian Forester.'

P. F. F.

Prothallia of Lycopodium.

C. J. Chamberlain, Prothallia and Sporelings of three New Zealand Species. *Botanical Gazette, Vol. LXIII, No. 1, pp. 50—64.*

The author gives a short resume of the literature of the subject, followed by notes on *L. laterale*, *L. volubile* and *L. scraiosum*, collected in New Zealand. He finds a green leafy prothallium, with protocorm developed, only in the first which is a terrestrial species. The other two species are epiphytic, and the prothallia are subterranean, with no protocorm. He suggests that this differentiation occurs throughout the genus: and that the green leafy prothallium represents the original type, and that the change to the saprophytic subterranean type occurred in consequence of a delay in germination (some spores require from 6 to 8 years) which allowed only those spores that had reached some place of safety, *i.e.*, had been buried to produce plants.

E. A. Spressard gives (l.c. pp. 67—78) a very interesting account of the finding of prothallia of *L. clavatum*, *L. obscurum*, *L. annotinum* and *L. lucidulum*, nearly all quite close together, in an open space near Marquette Michigan. They were found only on small knolls covered partly by *Polytrichum* and partly by a grass, or somtimes almost bare. He suggests as a reason for this that such spores as were carried and fell on these spots were first of all beaten into the ground by rain, then covered by the shifting sand, and finally conveyed to a favourable depth by percolating water. This theory worked well or guide to where to look for the prothallia. The paper establishes the fact that prothallia have been found in America, and announces the discovery of two new species of prothallia—*L. obscurum* and *L. lucidulum*. P. F. F.

Algae.

Hybrids of Spirogyra.—E. N. TRANSEAU ("Hybrids among species of Spirohyra." *American Naturalist, March-April 1919*) has published a paper recording the results of his experiments on hybridization in species of Spirogyra, especially between *S. communis and S. varians*, and *S. varians* and *S. porticulis*. He finds that hybrid zygospores may be formed between species even though they have very different vegetative and spore characters. The nuclei of the gametes do not fuse until after the zygospore-wall matures. The form of zygospore is determined entirely by the female gamete. Filaments derived from hybrid zygospores show their hybrid character in the dimension of filament; character of sporiferous cell and the form of zygospore.

Observations on Euglena Deses.—ROSE BRACHER ("Observations on Euglana deses". *Annals of Botany, January 1919*) has studied the effect of external factors like light, tidal flow and temperature changes on the movements of *Euglena Deses*. She finds that in darkness, at night or at the tidal time the Euglenæ burrow under the surface of the mud. As for the temperature, the Euglenæ are active at any temperature between 2·5° C. and 25° C., outside which movements are arrested. The optimum temperature is 15° C.,

Cytology of Tetrahedron minimum—A. Br.—G. M. SMITH ("Cell-structure and autospore formation in Terahedron minimum, *A. Br.*" Annals of Botany, October 1918) has published an illustrated account of the cell-structure and autospore formation in *Tetrahedron minimum*. The young cell contains a single nucleus and a pyrenoid. Repeated mitosis may result in 8 nuclei within a single cell. Autospores are formed by progressive cleavage the nuclei increasing in number at the same time, resulting in four, eight, sixteen or thirty-two uni-nucleate protoplasts, each of which finally becomes an autospore. The pyrenoid disappears after the first cleavage new pyrenoids being formed *de novo* in the young autospores.

Conjugation of Zygogonium ericetorum, Kutz,—W. J. HODGETTS (*New Phytologist, December 1918*) has carefully studied the process of conjugation in Zygogonium ericetorum. His observations confirm De Bary's account of conjugation in this alga. Greater part of the protoplast passes into the protuberance and is there formed into a sort of gametangium by its cutting off a curved partition wall. Each gamete secretes a thin wall round itself. Thus, before fusion, each gamete is surrounded by s double investment. Inner walls become only locally absorbed during the fusion and unite to form a continuous membrane round the zygospore, which persists as the outermost layer of its wall. Azygospores were also observed. Relation of *Z. ericetorum* to *Zygnema pachydermium* West, is discussed and the writer supports the retention of the genus, Zygogonium, on the basis proposed by De Bary (1858), and accepted by Mille (1897, 1909).

S. L. G.

Morphology and Histology

Dudgeon, Winfield. The Morphology of Rumex crispus, *Bot. Gaz., LXVI 5, pp. 393—420*, 7 figs.

In this paper the author gives a detailed account of the development and histology of the flower of *Rumex crispus*, as part of a study of the morphology of the whole plant. He find that in well developed flowers the development of the organs and of the embryo-sac and pollen grains follows the course usual in dicotyledons, with only slight variations. In the ovule the archespore is the terminal cell (below the epidermis) of a definite axial row. It divides into an upper cell which forms a 4-called cap, and a lower cell, the embryo-sac mother-cell. This divides into a linear or nearly linear axial tetrad, the lowest cell of which becomes the embryo-sac. The haploid chromosomes in the division of the mother cell are 32 in number. The chief interest in the paper lies in the author's account of the very widespread degenerations which occur at almost any stage in the growth of the floral organs. These degenerations may, he finds occur (a) in any or all of the anthers, at any stage from the spo-

rogenous initial to the mature pollen grain, and may involve only the sporogenous tissue and its products, or the entire anther; (b) in the ovary at any stage from the functioning megaspore to the maturing fruit, and may involve only the embryo-sac, or both embryo-sac and ovule, or the entire ovary; (c) in entire inflorescences. The degeneration is accompanied by, and probably caused by, the formation of a definite abscission layer across the peduncle, whereby the floral organs are cut off from nutriment, and is so common that functionally perfect flowers are rare. As a result of such degenerations four types of mature flowers are produced (a) physiologically staminate (the ovary being functionless) in which the pollen may or may not be functional; (b) physiologically ovulate, the stamens having been completely eliminated by degeneration; (c) bisporangiate, having both stamens and ovary functional (very rare); (d) comp'etely sterile, having functionless ovary and stamens completely eliminated. The author discusses shortly the bearing of these facts on the origin of dicliny, which he is inclined to consider may be due in other species also to gradual degenerations, and not as Strasburgher supposed to excessive mutation, nor to an absence of one sex in the seed, as suggested by Hoffmann, nor to hybridisation as Jeffrey believed.

P. F. F.

Seedling Structure.

Compton, R. H An investigation of the Seedling Structure in the Leguminoseæ. *Jour: Linn. Soc. (Botany XLI No. 279, pp. 1—129 (June 1919.)*

A description with illustrative figures is given of the distribution of the xylem and phloem in seedings of species taken from all sections of the order. It would be impossible in a brief note such as this to summarise or even indicate the facts and ideas which the author gives; but it is clear that there is considerable variation in the amount and arrangement of the xylem elements in the root from a solid tetrarc core, to a ring of eight separate Y-shaped masses (as seen in section.) Those interested would do well to read the paper. But two conclusions may be given here—one that the size of the seeds is correlated with the habit of the plant, trees having much heavier seeds than herbs or shrubs; the other that as with Angiosperms in general the tree habit is primitive, the herbaceous derived. As to whether the epigeal or the hypogeal mode of germination is the more primitive it is impossible to say. Both occur sometimes in the same genus, and the change from one to the other has probably occurred repeatedly in the evolution of the order.

P. F. F.

Pollination Mechanisms.

Wyley, R. B. The Pollination of Vallisneria spiralis. *Bot. Gaz. LXIII, pp. 135—145.*

The mechanism of pollination in the American plant differs markedly from that described by Koerner, and widely copied from his *Pflanzenleben.* The chief points are that the staminate flowers float on their recurved sepals, till

carried by the wind they are caught in the cup of depression formed in the surface film round a female flower. A very large number may be so caught. When by the action of waves the female flower is drawn down slightly the staminate flowers are forced against it, standing vertically to the (inclined) walls of the depression, and if the female flower is temporarily drawn under the surface, several male flowers are carried down with a bubble of air. They are then completely turned over the stigmas, and so pollinate them. Each male flower produces about 100 grains of pollen, and since 400 ovules may be fertilised in the ovary as much as the whole pollen of several flowers must adhere to the stigmas. The author suggests that possibly his plant and Kœrner's are not of the same species. The paper is illustrated with photographs, and is a useful re-investigation of a process, hitherto thought to be sufficiently explained. The author would like photographs and drawings of the process in other countries. Since the plant is common enough in Indian pools of water perhaps some one reading this will take the matter up.

P. F. F.

Physiology.

J. Loeb *in Bot. Gaz. for January, LXVIII, pp. 25—50*, continues his account of experiments on apogeotropism and the formation of roots in stems of *Bryophyllum*.

In this paper he examines the influence of leaves on the curvature of a horizontally placed stem. The stems were suspended over water in a closed jar. Very striking differences were shown in the rate and amount of geotropic curvature according to the position of the leaf, if only one is left on the stem. If the leaf is at the apical end curvature and root-formation are both much greater than when a basal leaf only is left. Curvature is due to a growth of the cortex, which is naturally in a state of tension. So that when the cortex is removed from the lower side the curvature is very slight, but if removed from the upper side it is very great. He finds that conditions which favour root-formation (*e.g.*, a leaf left at the apical end favour also curvature, while those, which favour shoot-formation (*e.g.*, a leaf left at the basal end) do not. He suggests therefore that each leaf has a tendency to send shoot-forming substances towards the apex, and root-forming substances towards the base of the stem; and that probably geotropic curvature is due to a specific substance (hormone) which is associated with or identical with the root-forming hormone, and that these hormones have a tendency to collect in the cortex of the lower side of a horizontal stem. The common phenomenon of a lateral branch taking the place of a decapitated stem by growing erect, (which he refers to as if only in certain Firs) would then be explained by the flowing of the shoot-forming hormones into a lateral branch near the (decapitated) apex. "After this the mechanical advantage due to the vertical position will favour the continued flow of these substances in this branch, which thus becomes the new apex." The theory is an interesting one and falls into line with Sach's theory of special root-forming substances. It would be of value to have experiments on these lines with plants of other genera.

P. F. F.

Plant Breeding.

Parnell, F. R.; Rangasawmi, G. N.; and Ramiah K. The Inheritance Characters of Rice. *Mem. Agri. Dept. India. Bot. Ser. IX 2.*

The authors find the simple ratio of 1 to 3 in several varietal characters of the grains and of the stem and leaves of paddy, *e.g.*, long outer glumes in place of the usual very short ones; a piebald arrangement of the dark colour of the furrows of the grain, as contrasted with its even distribution; and similarly a piebald distribution of a golden colcur of the inner glumes as contrasted with the full golden colour. This golden colour which appears as the grains ripen, in place of the more usual green ripening to a straw-colour is recessive to green. They find a purple pigmentation of various parts of the plant dominant over (the usual) green, the numbers of F_2 obtained being 41, 121 to 13,664 or very nearly 3 to 1. But since in some crossings a ratio of 9 to 7 is obtained the colour is without doubt, they say, due to the simultaneous presence of two factors, one of which occurred in *both* of the varieties giving the first set of numbers in the ratio 3 to 1 in F_2; while the varieties of the other set giving 9 to 7 were heterozygous to both. This fact was proved by the production of purple pigment in a cross between two pure strains both of which were green. A dark colouring of the pulvinus and auricle is similarly dominant over green. Other segregating characters are a purple striation of the internode, purple glumes, purple stigma and purple axil. Among these last they find 'coupling' occurred; *viz.*, purple striation with purple glumes, and purple stigma with purple axil; while green internodes and glumes are associated with purple stigma and axil, showing a repulsion which proved to be between purple stigma and both purple striation and purple glumes. Though 60,000 plants were examined for this, no example of incomplete repulsion was recorded.

Another varietal character examined was a black colour of the inner glumes, which fades to a smoky colour when the grain is quite ripe. This colour is, as in so many cases due to the combination of two factors. They find partial repulsion between both of these factors and that of purple striation of the internode.

Coming to the grain itself, inside the glumes, the red colour of some varieties was found to show the simple ratio of 3 : 1, indicating dominance over its absence; but in two natural crosses with red rice some of the F_2 plants had a grey-brown colour. Though the experiments at the time of publication were not complete enough to prove it, the authors think that this red colour is also due to the simultaneous presence of two factors.

P. F. F.

Printed and Published for the Proprietor by W. L. King at the Methodist Publishing House, Mount Road, Madras.

THE
Journal of Indian Botany.

VOL. I. OCTOBER, 1919. No. 2.

THE PHYSIOLOGICAL ANATOMY OF THE PLANTS OF THE INDIAN DESERT

BY

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PREFACE.

I had the opportunity of visiting a portion of the great Indian Desert, in the company of Fr. Blatter and Prof. Hallberg, in the months of October and November 1917. The year was remarkable for its abnormal rainfall of over 40 inches as against the average of 10—13 inches; and the herbaceous flora had survived till the time of our visit. On seeing the plants from the different habitats of the Desert identified by Fr. Blatter and Prof. Hallberg, it occurred to me that a treatise on the physiological anatomy of the Indian Desert plants would not be out of place. For while much has been written on other desert floras, nothing has been done in that line of any Indian Desert flora.

I set to work, with the view to carrying out my idea and the following treatise, in which I have confined myself to that portion of the Indian Desert which is marked in the map, is the result of my investigations.

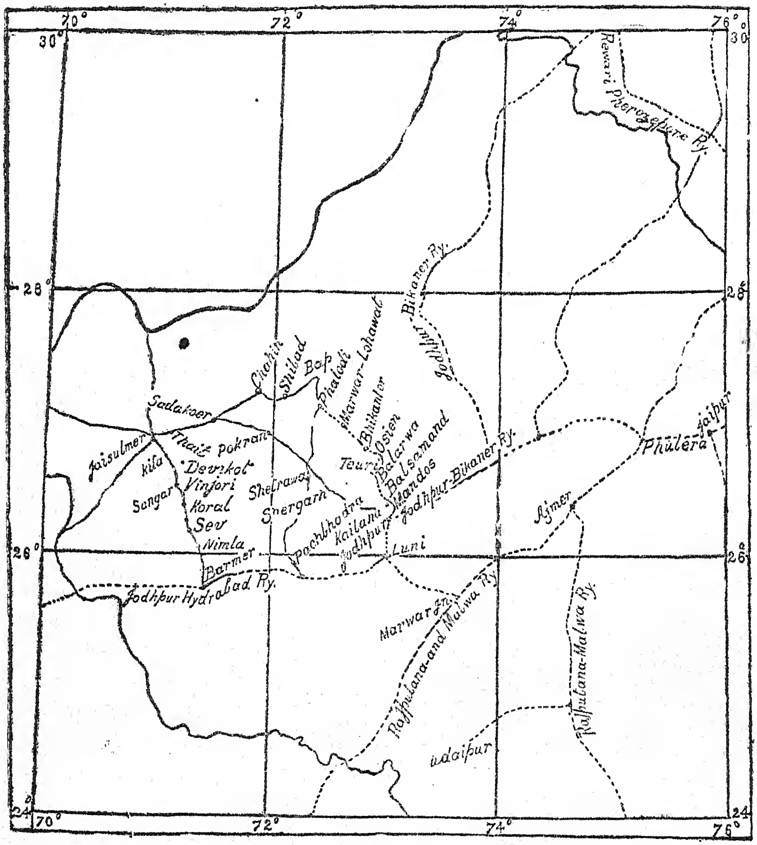
I have taken considerable care to provide accurate sketches of the transverse sections of the leaves and the axes, as it is generally found that accurate figures give a clearer idea than long explanatory notes. The drawings have been made with the aid of Abbé's Camera Lucida; and the different powers of the oculars and objectives have been noted. I have used a Zeiss's microscope and generally Zeiss's apochromatic objectives and compensating oculars.

I hope the essay will prove an addition to our knowledge of the Desert Flora in particular and of the comparative anatomy and physiology of plants in general.

I must use this opportunity to thank Mr. M. V. Unakar, Acting Director of the Bombay and Alibag Observatories for the meteorological data of the Indian Desert.

THE

RÁJPUTANA AGENCY



Scale: 1 Inch = 32 Miles or $\frac{1}{2{,}027{,}520}$

INTRODUCTION.

To one who has the opportunity of visiting the Desert, the flora will at once appear striking and in many respects different from that inhabiting other more favoured provinces. The general barrenness of the country, the dry practically rainless climate and the scorching heat of the sun, not to omit the general susceptibility to the wind, have so modified the external organs of the desert plants, that it is but natural to conclude that the internal structure and the processes that are going on in the plants must in like way have been acted upon by these external factors.

Physical Aspects of the Indian Desert

Some information about the topography, geology and the meteorological data of the area under consideration will elucidate the remark.

(*a*) *Topography.*—The portion of the Great Indian Desert, under consideration, is included in the two states Jodhpur and Jaisalmer and forms a square having the four towns Jodhpur, Bap, Jaisalmer and Balmer at its four angles. The general aspect is that of a succession of dry undulating plains and rolling sand-dunes of all sizes and shapes varying from 2 to 3 miles in length and 20 to 400 ft. in height. It is sparingly dotted with low bushes and isolated tufts of curious-looking plants, relieved here and there by green succulents and candelabra-like Euphorbias. Shifting sands are common and continually changing in size and shape. Villages are few and far between and consist of a few huts located round a well or a tank.

(*b*) *Geology.*—The region under survey is covered for the most part with wind-blown sand-dunes which are of the transverse type, *i.e.*, have their longer axes at right angles to the direction of the prevailing winds. From beneath these, rocks of earlier age crop out as isolated hills. Near Jodhpur the oldest rocks are schists belonging to the Aravalli system. These are overlain by rocks of volcanic origin, the Mallani series, with conglomerate at the base. Upon these, rest sand-stones of the Vindhyan age. At Balmer the rocks consist of sand-stones, grits and conglomerates containing ill-defined fossil remains. At Jaisalmer sand-stones and lime-stones of Jurassic age occur and Nummulitic rocks are common.

(*c*) *Meteorological data.*—It should be noted that the year 1917, the year of the tour, was remarkable on account of the abnormal amount of rainfall. The data of the normal maximum and minimum temperature, relative humidity of the air, rainfall and number of rainy days are obtained by averaging the observations of 14 years (pp. 36 & 37).

(*d*) *General Plan.*—As regards the general plan and arrangement of the subject the orders have been described in the sequence of

METEOROLOGICAL DATA :—

Stations.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
(1) Normals : Maximum Temperature.													
	°	°	°	°	°	°	°	°	°	°	°	°	°
Jodhpur ...	76.1	80.0	91.1	100.7	106.5	104.6	97.7	9.33	94.9	96.9	89.7	79.7	92.6
Pachbhadra ...	78.4	83.2	94.6	106.3	107.8	105.7	97.7	94.8	97.2	98.7	90.7	81.5	94.7
(2) Normals : Minimum Temperature.													
	°	°	°	°	°	°	°	°	°	°	°	°	°
Jodhpur ...	49.6	53.0	62.9	72.6	80.2	82.7	80.5	78.0	75.5	67.5	58.5	52.7	67.8
Pachbhadra ...	45.1	48.9	58.3	69.6	77.5	81.1	79.7	77.3	75.2	64.9	54.1	46.3	64.9
(3) Normals : Relative Humidity of the Air.													
	%	%	%	%	%	%	%	%	%	%	%	%	%
Jodhpur ...					Not available.								
Pachbhadra ...	46.1	33.1	33.7	34.3	42.7	52.4	66.8	70.1	64.5	46.2	38.1	42.9	48.1
(4) Normals : Rain-fall.													
	"	"	"	"	"	"	"	"	"	"	"	"	"
Jaisalmer ...	0.21	0.20	0.20	0.13	0.22	0.69	2.17	2.28	0.83	0.01	0.04	0.07	7.00
Balmer ...	0.11	0.14	0.07	0.05	0.32	1.22	3.51	3.13	1.52	0.02	0.08	0.05	10.22
Pachbhadra ...	0.26	0.15	0.10	0.08	0.51	1.28	3.64	3.71	2.03	0.05	0.06	0.10	11.96
Jodhpur (Obs.) .	0.17	0.22	0.06	0.14	0.25	1.23	4.21	4.31	2.40	0.11	0.10	0.14	13.34
Phalodi ...	0.15	0.23	0.13	0.08	0.21	1.06	3.04	3.16	0.78	0.00	0.02	0.09	8.95

(5) Normals: Number of Rainy Days.

Jaisalmer ..	0.6	0.7	0.4	0.6	0.6	1.3	3.7	3 7	3.4	0.0	0.1	0.2	13.0
Balmer	0.5	0.3	0.2	0.2	0.5	1.8	4.3	4.0	2.3	0.1	0.2	0.2	14.6
Pachbhadra ...	0.7	0.5	0.3	0.3	0.9	2.1	5.2	4.9	2.4	0.2	0.2	0.3	18.0
Jodhpur (Obs.) ...	0.5	0.6	0.2	0.5	0.7	1.9	5.0	5.7	2.5	0.2	0.2	0.5	18.5
Phalodi	0.7	0.5	0.4	0.1	0.5	1.7	3.7	4.4	1.2	0.0	0.0	0.2	13.4

(6) Actual Rain fall for 1917.

	″	″	″	″	″	″	″	″	″	″	″	″	″
Jaisalmer ...	0.00	0.00	0.00	1.33	1.73	2,17	0.60	8.44	7.73	0.62	0.00	0.02	22.64
Balmer	0.00	0.00	0.30	0.20	1.24	1.64	7.01	6.21	4.20	2.70	0.00	0.00	23.50
Pachbhadra ...	0.00	0 00	0.00	0.10	3.07	6.50	8.08	5.19	3.88	5.00	0.00	0.00	31.82
Jodhpur (Obs.) ...	0.04	0.20	0.10	1.12	4.15	4.75	5.78	14.20	5.74	6.02	0.00	0.25	42.35
Phalodi	0.00	0.00	0.00	1.79	2.41	1.74	0.30	10.24	6.50	2.70	0.00	0.00	25.68

(7) Number of Rainy Days 1917.

Jaisalmer ...	0	0	0	3	3	2	3	13	9	1	0	0	34
Balmer ...	0	0	1	1	2	3	3	10	7	2	0	0	29
Pachbhadra ...	0	0	0	1	5	5	4	4	6	1	0	0	26
Jodhpur (Obs) ..	0	1	1	4	6	2	5	10	14	3	0	1	47
Phalodi... ...	0	0	0	4	4	4	1	14	8	1	0	0	36

Bentham and Hooker's system of classification. I have chosen the representative plants from the different parts of the desert and have examined fifty orders, 125 genera and 165 species. In dealing with the individual order, I have described the specific characters, the structure of the leaf and the structure of the axis and when necessary I have appended a general review of the order. I have omitted the structure of the root, as generally it is not available in herbarium specimens. The specific characters that are considered are just those that will be useful in the diagnosis of the species. The different structures are considered in detail under the heads of "The structure of the leaf" and "The structure of the axis". The characters which are common to both the leaf and axis are usually dealt with jointly under the structure of the leaf as they are more prominent in the leaf.

I have embodied the interpretations of the various modifications of the different tissues in the descriptions of the structures of the leaf and the axis, and in the general review of the order, so that the descriptions can be said to contain at once an account of the anatomy and physiology of the plants in question. The concluding remarks at the end of the principal part of the work serve as a concise and complete summary of the treatise.

(e) *Method.*—As regards the method employed in preparing the herbarium material for the section work, small pieces of the leaves and the axes were soaked in water for about two hours and then hardened in formalin alcohol for about a day. The sections which were cut in 90 per cent. alcohol were placed, before mounting in glycerine, in a few drops of lactic acid on a slide and slightly warmed over a burner, so that the cells of the different tissues might expand to their proper dimensions.

(f) *A suggestion.*—The idea of employing micro-anatomical and micro-chemical characters for systematic purposes originated in times as early as those of Linnæus, and has been repeatedly put forward by several botanists, Radlakofer being considered as the founder of the anatomical method. It would be presumptuous on my part to discuss the merits of the method for systematic purposes; but from what little I have observed in my study of the physiological anatomy of the desert flora, I have grounds for believing that the study of Systematic Botany would considerably progress were more attention paid to anatomical characters than has heretofore been done. The method is no doubt laborious and a systematic botanist would be loth to adopt it, owing to the huge amount of the material submitted to him for identification from all sides. I admit this difficulty and suggest that the anatomical characters should be used at least as confirmatory evidence in establishing genera and species.

MENISPERMACEAE.

Cocculus cebatha *DC.*—*Figs.* 1, 2. (p. 39)—Epidermis of the leaf composed of thin-walled tabular cells. Stomata occurring on both the surfaces. Subsidiary cells accompanying the guard-cells. Mesophyll composed wholly of palisade cells. Internal glands absent. Pith cells containing clusters of acicular crystals of oxalate of lime. Clothing hairs bicellular and curved. Glandular hairs absent. Veins embedded and enclosed in green sheaths. Axis slightly ribbed, ribs strengthened by a few sclerenchymatous fibres. Epidermal cells of the axis tabular with outer walls greatly thickened and cuticularised. Cortex formed of chlorophyll containing parenchyma. Pericycle composed of large groups of stone-cells. Wood formed of xylem bundles separated by broad medullary rays extending to the cortical chlorenchyma. Groups of cells resembling bast fibres on the inner face of the xylem bundles. Pith composed of thick-walled cells.

Structure of the leaf.

Epidermis is composed of tabular cells, with outer walls flat and a little thickened. Lateral and inner walls are thin and the former are straight. Stomata are accompanied by subsidiary cells and are more numerous on the under-surface. Guard-cells are situated on a level with the surrounding cells, with the front cavity slightly depressed, or on a level with the surface, fig 1. The mesophyll is composed of a homogeneous tissue of short palisade cells. Internal glands are absent in the leaf as well as in the stem. Oxalate of lime is not found in any form in the leaf.

Veins are embedded and are enclosed in green bundle sheaths. Veins of the mid-rib, which is prominent above and below, are vertically transcurrent above and below by collenchyma; the bundles are protected on the lower side by small groups of stone-cells.

Hairy covering on the leaf and axis consists of clothing hairs. Clothing hairs are made up of a short thin-walled basal cell and of a long curved thin-walled pointed terminal cell.

Structure of the axis.

Epidermal cells are small and tabular with outer walls very greatly thickened and cuticularised. Lateral and inner walls are thin and the former are straight. The axis is slightly ribbed, the ribs being strengthened by a few sclerenchymatous fibres.

The cortex is formed of chlorophyll containing parenchyma which extends to the medullary rays between the groups of stone-cells of the sclerenchymatous pericycle. The pericycle consists of large groups of stone-cells separated by the chlorophyll containing parenchyma of the

cortex. The wood (Fig. 2) is composed of large xylem bundles separated by broad medullary rays which come into contact with the chlorophyll containing parenchyma of the cortex. Vessels are large and have simple perforations. Groups of cells, resembling bast fibres, are present on the inner side of the xylem. Inter-fascicular wood-prosenchyma is not developed. The endodermis is not differentiated. The soft bast occurs in groups on the outer side of the xylem, separated by medullary rays. The pith is composed of thick-walled cells and some of these contain small clusters of acicular crystals of oxalate of lime.

CRUCIFERAE.

Farsetia jacquemontii *Hook.*, *Figs.* 3, 4, 5, 6.

Woody. The middle tissue of the mesophyll composed of large colourless polygonal cells with water-storage function. Neither surface of the leaf grooved. Axis not furrowed. Assimilatory tissue of the axis composed of short palisade cells. Sclerenchymatous pericycle in the form of a few scattered bast fibres. Vascular ring broad with vessels uniformly distributed in incomplete rows and more numerous in the lower half.

Farsetia macrantha *Blatt. and Hall.*, *Figs.* 4, 7, 8 Herbaceous. Middle tissue of the mesophyll composed of chlorophyll containing horizontally elongated cells with assimilatory function. Lower surface of the leaf characterised by ridges and furrows. Axis furrowed. Assimilatory tissue of the axis formed of an outer portion of palisade cells and of an inner portion of chlorenchyma. Sclerenchymatous pericycle in the form of closely placed large groups of bast fibres. Vascular ring undulate and composed of small vascular bundles connected by narrow strands of interfascicular wood prosenchyma with cells resembling stone cells.

Structure of the Leaf.

Epidermis consists of horizontally tabular cells with outer walls greatly thickened and arched convexly outwards. Lateral walls are undulate. Stomata occur on both the surfaces and are accompanied by subsidiary cells one of which is smaller than the other two. The front cavity is placed in a depression formed by outer thickened walls of the epidermal cells. Guard cells are placed in the plane of the surrounding cells. (Fig. 5.) Stomata on the axis are numerous and have the same characters as those on the leaf. Mesophyll is isobilateral, and is characterised by a middle tissue which is composed of large thin-walled colourless polygonal cells, perhaps acting as water reservoirs in *F. jacquemontii* (Fig. 3) and of horizontally elongated green cells in *F. macrantha* (Fig. 7.) Internal secretary organs

are not found in either of the species. Veins are embedded and are provided with sheaths of thickened green cells. The bundles are accompanied by arcs of collenchyma on the lower side, protecting the phloem of the veins. Hairy covering on the leaf and axis consists of densely placed clothing hairs. The hairs are unicellular, two-armed with their thin walls bearing knobs incrusted with carbonate of lime, fig. 4. The hairs are appressed, filled with air and white; and protect the plants from insolation by reflecting the rays of light. Glandular hairs do not occur in either of the species.

Structure of the axis.

Epidermis is composed mostly of vertically tabular cells with outer and inner walls greatly thickened and cuticluarised, much more so in *F. macrantha.* Lateral walls are thin and undulate.

Primary cortex is characterised by assimilatory tissue composed of short palisade cells in *F. jacquemontii* (fig. 6) and of palisade tissue on the outer side and chlorenchyma on the inner side in *F. macrantha* (fig. 8). Sclerenchymatous pericycle is represented in *F. jacquemontii* (fig. 6) by a few scattered bast fibres, and in *F. macrantha* by numerous closely placed groups of bast fibres, (fig. 8.) The wood in *F. jacquemontii* (fig. 6) is quite composite and has vessels uniformly distributed in incomplete rows, the vessels being more numerous and larger in the lower half. In *F. macrantha* (fig. 8) the vascular ring is undulate and is composed of very small xylem bundles connected by narrow strands of interfascicular wood prosenchyma formed of thick walled cells having small lumina. There are large groups of wood parenchyma enclosing the lower portions of the xylem bundles. Medullary rays do not occur in either of the species.

The pith is composed of thin-walled cells.

Capparidaceae.

Cleome papillosa *Steud.* Figs. 10, 11, 12, 17, 18. Herbaceous. Epidermal cells with outer walls strongly papillose. Guard cells in the plane of the surrounding cells. Mesophyll composed of palisade tissue on the adaxial side and of arm-palisade tissue on the abaxial side. Veins not provided with bundle sheaths. Internal glands absent. Glandular hairs multicellular and capitate. Outer walls of the epidermal cells of the axis superficially granulated. Assimilatory tissue in the axis formed of chlorophyll containing parenchyma. Pericycle consisting of long, thin groups of stone cells. Wood composite. Soft bast occurring in groups. Pith formed of thick-walled cells.

(*To be continued.*)

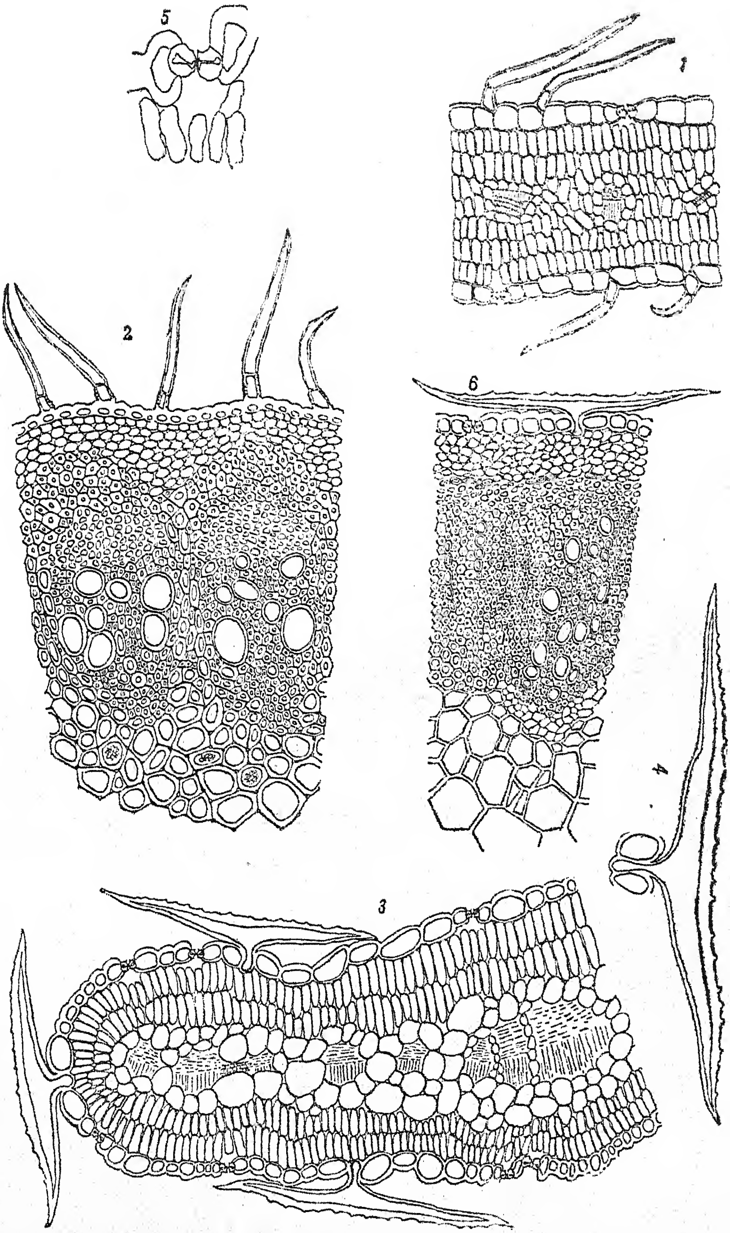
Abbreviations used in the explanation of the plates.

Oc.—ocular.
Com.—compens. ocular.
Ob.—objective.
Ap.—apochromatic.
T.S.—transverse section.
A—water-storing cell.
G.—internal gland cell.
L.C.—lysigenous cavities.
G.C.—secretary cavities.
Cl.—collenchyma.

Plate I.

1-2. *Cocculus Cebatha.*
 1 T.S. of the leaf.
 Oc. 6 Com.; Ob. 8 mm. Ap.
 2 T.S. of the axis.
 Oc. 8 Com.; Ob 8 mm. Ap.
3-6. *Farsetia Jacquemontii.*
 T.S. of the leaf.
 Oc. 3 Com.; Ob. 3 mm. Ap.
 4 Hair on the axis.
 Oc. 2 Com.; Ob. 3 mm. Ap.
 5 Stoma on the leaf.
 Oc. 6 Com.; Ob. 3 mm. Ap.
 6 T.S. of the axis.
 Oc. 2 Com.; Ob. 3 mm. Ap.

N.B.—To get the original dimensions multiply by 1·7.

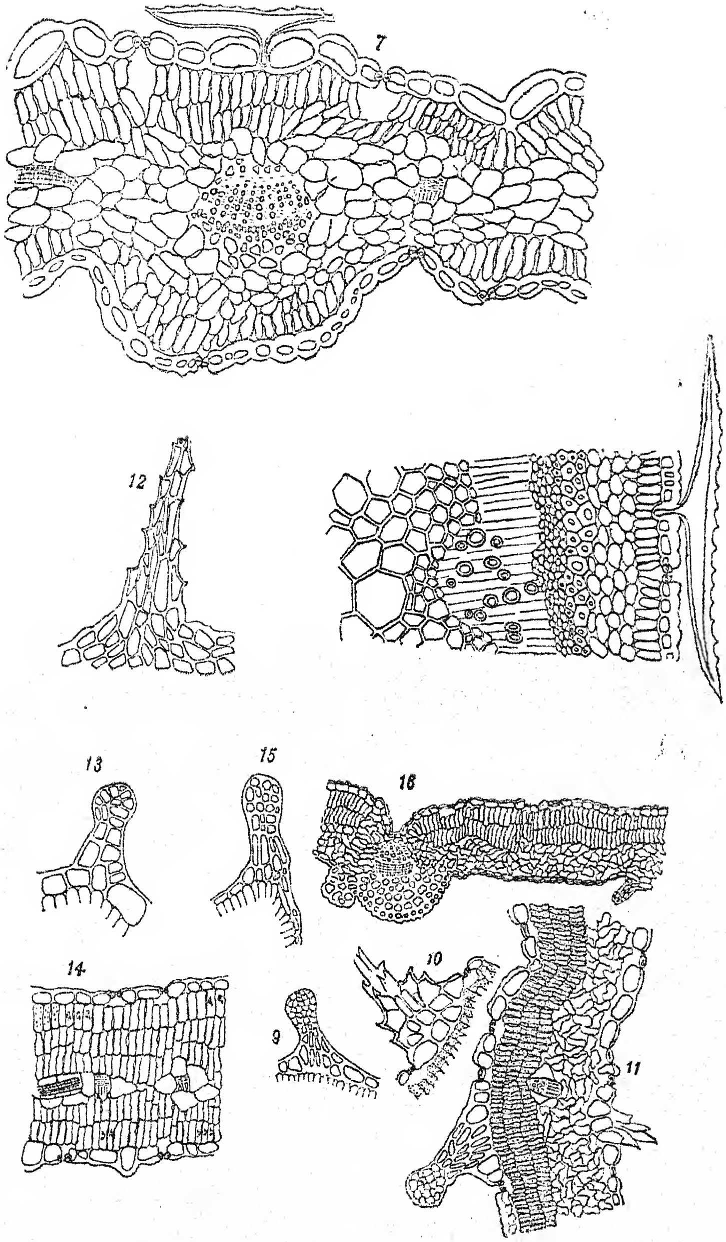


T. S. Sabnis del. PLATE I.

Plate II.

7-8 *Farsetia Jacquemontii.*
  7 T.S. of the leaf.
    Oc. 2 Com.; Ob. 3 mm. Ap.
  8 T.S. of the axis.
    Oc. 2 Com.; Ob. 3 mm. Ap.
9-12 *Cleome papillosa.*
  9 Glandular hair on the leaf.
    Oc. 1; Ob. C.
  10 Glandular hair on the leaf.
    Oc. 1; Ob. C.
  11 T.S. of the leaf.
    Oc. 2; Ob. C.
  12 Hair on the axis.
    Oc. 1; Ob. C.
13-14 *Cleome brachycarpa.*
  13 Glandular hair on the leaf.
    Oc. 1; Ob. 7.
  14 T.S. of the leaf.
    Oc. 2; Ob. C.
15-16 *Cleome viscosa.*
  15 Glandular hair on the leaf.
    Oc. 3; Ob. C.
  16 T.S. of the leaf.
    Oc. 2; Ob. C.

N.B.—To get the original dimensions multiply by 1.7.



T. S. Sabnis del.

PLATE II.

A NOTE ON CERTAIN SPECIES OF POLYGALA

BY

K. Rangachariar, M.A., and C. Tadulingam, F.L.S.

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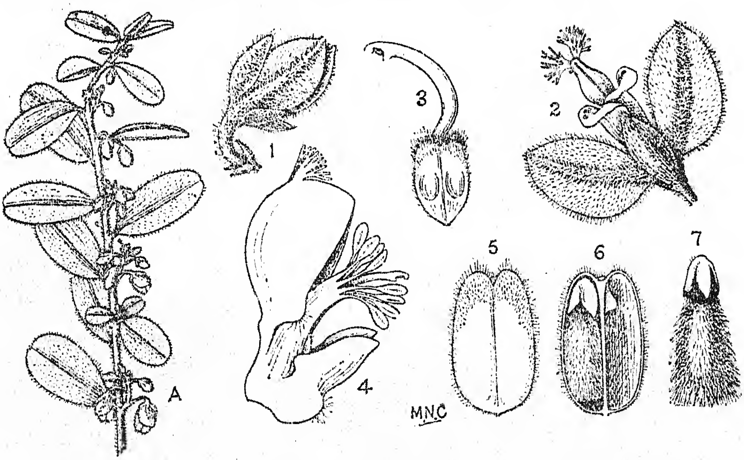
During the month of December last year some species of Polygala came up in great profusion and they were unusually dominant on the Estate of the Agricultural College. They consisted of the four species dealt with in this note. Out of these four, only one, *Polygala chinensis* L. is included in Hooker's Flora of British India, and in Gamble's Madras Flora this species and *Polygala bolbothrix* Dunn are included. The other two species are merged under *Polygala erioptera*, DC. Prod. i. 326 and *Polygala chinensis* Linn., although they differ very much from these species. In Wight and Arnott's Prodromus 1.36, *Polygala Vahliana* DC. is treated as a distinct species.



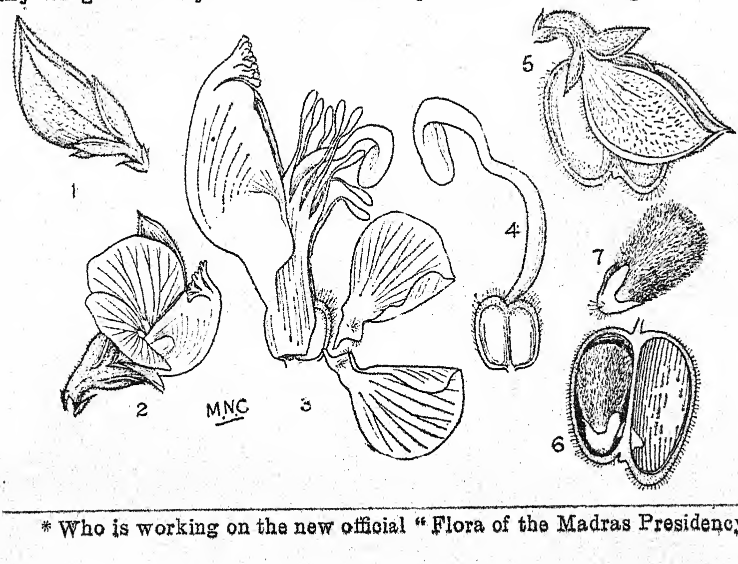
Text fig. 1. P. Vahliana:—A. a branch, 1. flower-bud, 2. an open flower, 3. ovary, 4. corolla, 5. fruit, 6 fruit cut open, 7 seed.

1. Polygala Vahliana *DC. Prod. 326* :—This is a freely branching herb. Stems and branches are procumbent and pubescent. Leaves are oblong, narrowed downwards into a petiole, obtuse, mucronulate or not, softly hairy on both the surfaces and varying in length from 3/16 to 7/16 inch. Racemes are very short, opposite to the leaves or lateral, 3 to 6 flowered; bracteoles are very small and persistent. The two inner larger sepals are somewhat membranous with a green mid-nerve, elliptic, villous and about as long as the fruit. The petals are pinkish and the keel is cristate. The capsule is very small, oval, emarginate, glabrous on the faces and softly villous at the edges only

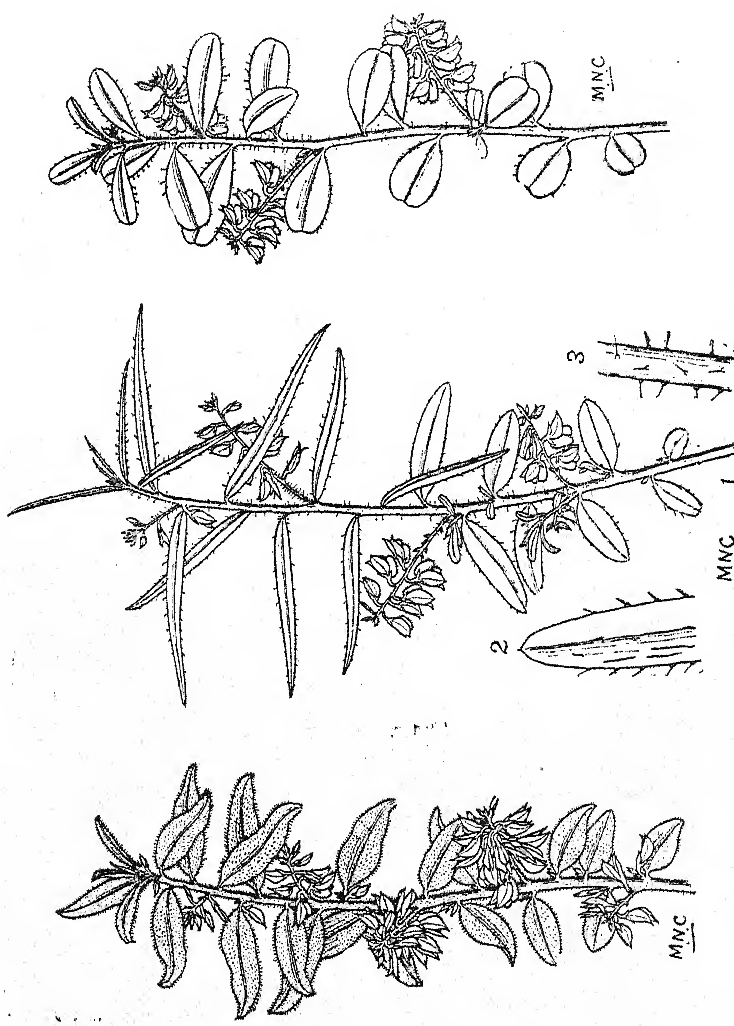
1/8 inch long and 1/16 inch broad. Seeds are narrow, strophiolate and without any appendages.

This plant matches very well with Wight's type specimen No. 131 in the Madras Herbarium named *Polygala Vahliana* DC. It is quite distinct from *Polygala erioptera*, DC. 1. 326. and differs from it in several points. *Polygala Vahliana*, DC. is a prostrate plant with oblong hairy leaves, and it has villous sepal wings and pinkish petals, whereas *Polygala erioptera* DC. is an erect one with stiff branches and almost glabrous linear leaves and has quite glabrous wing sepals and yellow petals. Specimens of this plant were sent to Mr. Gamble* and he now considers this to be a distinct variety of *Polygala erioptera*. The differences are, we think, quite sufficient to consider this as a distinct species, as is done by Wight and Arnott in their Prodromus.

2. **Polygala** sp:—This is an annual herb. Stems and branches are mostly procumbent and densely hairy. Leaves are either ovate-oblong, obtuse rarely retuse, or oblong-lanceolate to oblong-linear, acute, mucronulate, shortly petioled and with soft hairs scattered on both the surfaces. Racemes are shorter than the leaves, lateral, densely softly hairy with a few to many short pedicelled flowers closely set. The larger inner sepals are greenish with membranous margins, thinly hairy all over, obliquely ovate lanceolate, acuminate, about as long as or a little longer than the capsule. Petals are rose-purple. Capsule is oblong, longer than broad, about $\frac{1}{8}$ inch or a little longer, with unequal lobes, oblique and emarginate at the apex, margin ciliate. Seeds are oblong, with a three-fid strophiole without any wings or rarely two arms with very short obscure wings.



* Who is working on the new official "Flora of the Madras Presidency."



(B) P. arvensis Willd.

(C) P. bulbothrix Dunn I.

(D) P. bulbothrix Dunn II.

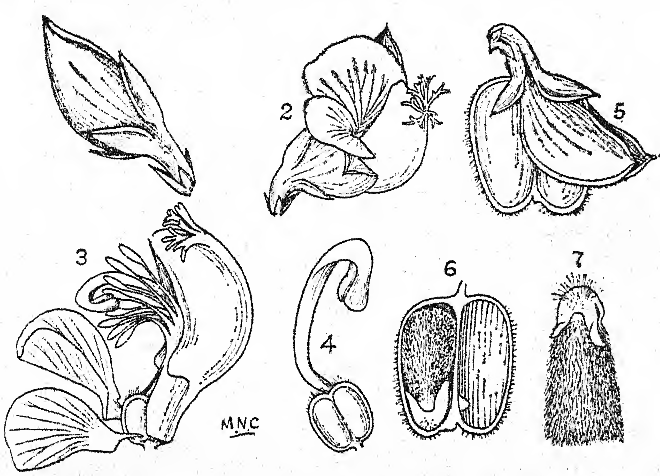
Text fig. 2. Fig. B. p. 46 a branch. Text Fig. 2. 1. flower-buds, 2. open flower, 3. petals and ovary, 4 ovary 5. fruit, 6 fruit cut open, 7. seed.

This species is no doubt closely allied to *Polygala chinensis* L., but differs from it in the following respects. The stems and leaves are more pubescent than in *Polygala chinensis* L., the flowers are smaller than those of the other, rose-purple and not yellow, the wing sepals are pubescent and not glabrous, the capsules are oblong and longer than broad and not rounded and broader than long as in *Polygala chinensis* L., seeds are oblong and not broadly ovate oblong and plumpy, strophiole is without any wing or rarely with minute obscure wings on two of the arms, not with wings as in *Polygala chinensis* L.

These differences are sufficient to consider this a distinct species. As the name *Polygala arvensis* Willd. is a synonym of *Polygala chinensis* L., a new name should be given to this plant. Specimens of this plant are being sent to Mr. Gamble and to Kew, and after hearing from them this will be named.

This plant appears to be the one described by Wight and Arnott in their Prodromus as *Polygala arvensis* Willd. *var.* γ and it is figured in Rheede's Hort. Mal. Vol. 9 t. 61.

3. **Polygala bolbothrix** *Dunn.* This is a freely branching annual herb. Stems and branches are diffuse, prostrate and the whole plant is covered with scattered bulbous-based hairs. Leaves are linear-oblong to narrowly oblong linear, glabrous, obtuse, mucronate, varying in length from ½ to 1½ inches, margins with distant bulbous-based



cilia, especially so on the lower half. Racemes are extra axillary,

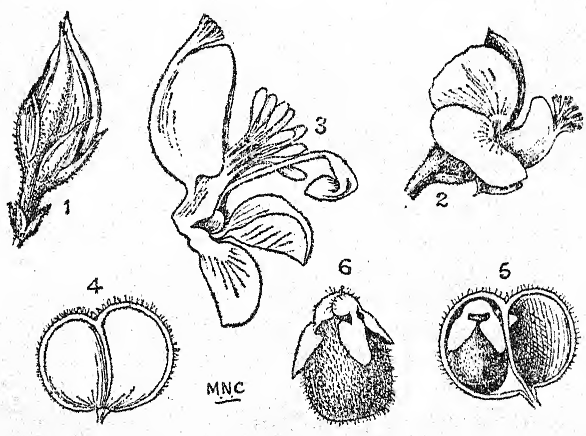
twice as long as the leaf or more when fully grown, and many flowered. The two inner large sepals (wings) are membranous-margined, ovate, acute, glabrous and slightly longer than the capsule. The capsule is small, slightly oblique, not margined, glabrous and rigidly ciliated on the margin and emarginate. Seeds are oblong and strophiolate without wings or sometimes the two arms with very obscure wings.

Fig. C., p. 46, 1. branch, 2. a bit of a leaf with cilia, 3. bit of stem, (D) branch of the broad-leaved form. Text fig. 3. Parts of the flower. 1. flower-bud, 2. open flower, 3. petals, stamens and ovary, 4. ovary, 5. fruit, 6. fruit cut open, 7. seed.

This plant is described as *Polygala ciliata* (L) by Wight and Arnott in their Prodromus Vol. I p. 38, and it is renamed as *Polygala olbothrix* by Mr. Dunn (vide Kew. Bulletin No. 3. 1916, p. 63). The name *Polygala ciliata* (L) could not be retained as this was applied to a species of *Salomonia* by Linnaeus. Evidently the plant referred to by Wight and Arnott in their Prodromus cannot be *Polygala ciliata* L., and the synonym should be *Polygala ciliata* of W. & A. Prodromus i. 38.

The form here described has long linear leaves and this was abundant here. The other form which is more common has ovate or obovate leaves.

4. Polygala chinensis *L.*—This can be distinguished from the others easily. The flowers of this species are yellow, the fruit is rounded, broader than long, the seeds are ovate oblong, plumpy and the strophiole is provided with well developed wings.



Text fig 4.—1. flower-bud, 2. open flower, 3. petals and ovary, 4. fruit, 5 fruit cut open, 6. seed.

THE INDIAN SPECIES OF ERIOCAULON.

BY

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Presidency College, Madras.

The difficulty of identifying from published descriptions the species of ERIOCAULON found in South India led me finally to attempt a revision of the Indian species from material available in the herbaria of this country. A full account with photographs of the type or other sheet of most of the species will appear in the *Records of the Botanical Survey of India*, but as it seems probable that it will not be published for some considerable time, a short resume no may not be out of place, and may perhaps be of assistance to collectors of this difficult genus.

The genus was mongraphed in *Das Pflanzenreich* in 1903, by Ruhland, who separated and arranged the species according to the number of the parts in each whorl of the flower, to the geographical distribution (Old and New Worlds) and to minor characters of various kinds. Taking only the species which occur in India it appears to me that they fall naturally into eight groups, or sub-genera, in each of which a tendency to reduction of the floral parts continually shows itself, so that Ruhland's arrangement according to the number of the parts and the perfection of the flower cuts across the natural groupings. The arrangement in the *Flora of British India* follows in some respects more natural lines, but too much stress is laid in most of the descriptions on unimportant characters, and the possession by some species of white or yellow anthers, instead of the more usual black, is altogether ignored.

The least modified species appear to be glabrous plants with short discoid stem, narrow leaves, and peduncles bearing heads of male and female flowers, each subtended by a black slightly hairy floral bract; and having in the male three sepals combined into a spathe-like calyx split on the upper side, a funnel-shaped corolla with three equal lobes and six stamens with black anthers; and in the female three equal, boat-shaped sepals, three equal oblanceolate ciliate petals, a superior ovary with three one-seeded lobes, and a three-fid style. From this fairly primitive type development appears to have proceeded along several different lines to produce groups of species as follows:—

I. SIMPLICES. Land or water-plants with the characters given above. Some of the species have (*a*) glabrous, some (*b*) villous receptacle. In both sub-groups reduction occurs in the female sepals, one

of which may be reduced to a mere bristle or be absent altogether. This reduction, which is found also in other groups, is clearly correlated with the compression of the flowers in the head, for it is the medial, ad-axial, sepal which is reduced in each case.

To this group belong (*a*) *E. Geoffreyi* sp. nov. (fig. 2), *E. Collettii* Hook. f., *E. barba-caprae* sp. nov., *E. gregatum* Koern., *E. nepalense* Presc., *E. Pumilio* Hook f., *E. truncatum* Han., *E. Trimeni* Hook. f., and *E. Duthiei* Hook f.; (*b*) *E. xeranthemim* Mart., *E. luzulaefolium* Mart., *E. Thwaitesii* Koern., *E. achiton* Koern., *E. quinquangulare* L., *E. roseum* sp. nov., *E. trilobum* Ham., *E. collinum* Hook. f., *E. Dianæ* sp. nov., and *E. Sedgwickii* sp. nov.

II. SETACEUM. Submerged plants with elongate stems and linear leaves. The heads and flowers are small, but as in I. To this belong *E. setaceum* Linn. (not of F.B.I.) and *E. intermedium* Koern. (incl. E. setaceum of F. B. I.)

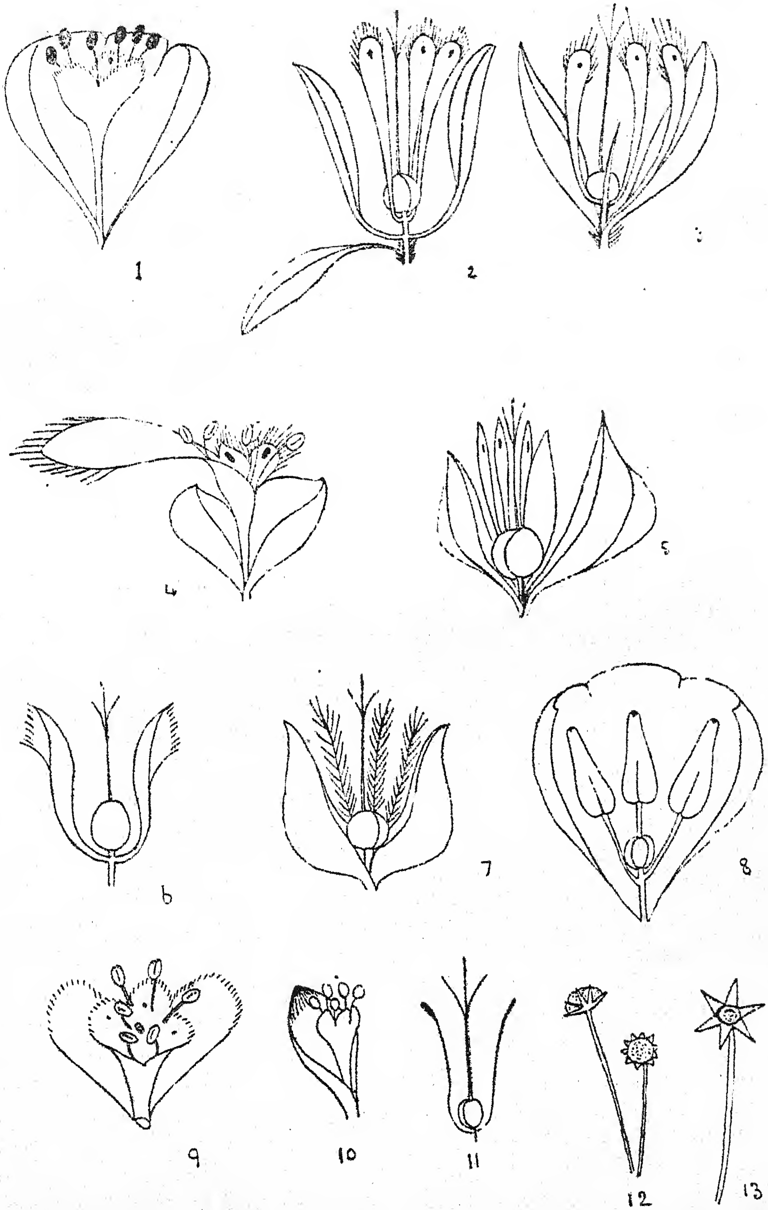
III. HIRSUTAE. Whole plant hairy, otherwise as in Ib. To this belong *E. Brownianum* Mart. (incl. *E. nilagirense* Steud.), *E. robustobrownianum* Ruhl., *E. gracile* Mart., *E. Rhodae* sp. nov., *E. Wightianum* Mart, (incl. *E. Helferi* Hook f.) and *E. lanceolatum* Miq.

IV. ANISOPETALAE. One male petal much enlarged and projecting beyond so as to hide the floral bracts (fig. 4), otherwise as in Ib. To this belong *E. odoratum* Dalx., *E. longicuspis* Hook. f., (incl. *E. polycephalum* Hook. f.,), *E. atratum* Koern., *E. ceylanicum* Koern. (incl. *E. subcaulescens* Hook. f.), *E. caulescens* Steud. (incl. *E. robustum* Hook. f.) and *E. cristatum* Mart.

V. SCARIOSÆ. Involucral and floral bracts glabrous and scarious, otherwise as in Ib. To this belong *E. oryzetorum* Mart., *E. Hamiltonianum* Mart., and *E. Edwardii* sp. nov.

VI. CRISTATO-SEPALAE. Female sepals strongly boat shaped, and crested or swollen along the keeli; otherwise as in I. *E. Margaretae* sp. nov., *E. Eleanorae* sp. nov., *E. minutum* Hook. f., *E. stellulatum* Koern., *E. echinulatum* Mart., *E. cuspidatum* Dalz., *E. sexangulare* L. (incl. *E. longifolium* Nees.) and *E. Thomasi* sp. nov. The last three species having thick rather than crested keels should possibly be separated into another group, but only an examination of species of other countries could determine this. The group appears to have its centre in north South America. Considerable reduction in sepals and petals occurs (figs. 5, 6, 7).

VII. CONNATO-SEPALAE. The female sepals are connected into a spathe like calyx, like the male of other groups *E. alpestre* Hook. f. (fig. 8). A small group apparently confined to China, Japan and the Tibetan Himalayas, and quite distinct from any other Indian species.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VIII. LEUCANTHERAE. The anthers are white or yellow; otherwise as in Ib. Many are water plants, with linear leaves. The group should probably be considered as of equal rank to the rest of the groups taken together. To it belong *E. horsley-kundæ* sp. nov., *E. breviscapon* Koern., *E. rivulare* Dalz., *E. miserum* Koern., (incl *E. mitophyllum* Hook. f.), *E. fluvatile* Trimen., *E. Sieboldianum* Sieb. et Zucc. (Figs. 9, 10, 11.)

Many of the characters on which stress is laid in the published descriptions of species, such as the twisting of the scapes or the length of the pedicel, are either common to all species or dependant on age, and are therefore only an encumbrance to critical definition. Leaving these on one side and confining attention to the characters given above and their modifications, the species are found to be much more easily separable than has hitherto appeared. Following on this it is clear that some of the species have in the past been given far too wide a range of distribution, because of faulty identification and consequent confusion with other species. Thus *E. luzulaefolium* Mart., given in the F.B.I. and other works as occurring throughout India, is confined to the hilly tracts of Eastern Bengal and the Shan states; *E. quinquangulare* L. belongs only to South India, and chiefly to the eastern side; and its place in Bengal is taken by *E. trilobum*, which does not occur in the Peninsula.

Several new species are described, but it is recognised that some at least of these may not be new, for I have failed to identify several described by Ruhland and others. Perhaps the strangest of the latter is *E. melaleucum* Mart., a species which occurs in the F.B.I. and in other floras but has no named representative in the Herbarium of the Royal Botanic Gardens, or in any other Indian Herbarium. Ruhland describes the anthers as white, and my E. horsley-kundae (fig. 9) may therefore be it, but Martius' original description is not quite definite enough and those of subsequent writers point to the probability of its having been confused with other species.

An interesting evolutionary fact comes to light in the existence of paralled development in different strains. Thus a reduction of one female sepal from a boat-shaped to a flat scale occurs as *E. collinum* crosses from S. India to Ceylon; *E. trilobum* in Bengal differs from *E. quinquangulare* in S. India hardly at all, except in somewhat more pronounced a reduction; and both these have their counterparts in *E. Dianæ* (fig. 3) in the Bombay Presidency, where every stage of this reduction can be seen. Again a lengthening of the involucral bracts so that the head appears rayed occurs in Group I in *E. Dianæ*, in the stock of *E. quinquangulare* as var. *Martiana* (mihi) and as *E. roseum* (mihi) (fig. 13) and in *E. xeranthemum*; in group III it occurs in var.

Kurzii of *E. gracile* and in group V. in *E. Edwardii*. A reduction of the female petals till they are only as wide as the hairs which spring from the base and form with them a tuft or brush, occurs in group I. in *E. Thwaitesii*, and in group VI. in *E. sexangulare* (see fig. 7). From the former species arose *E. achiton* with no petals at all. The submerged habit is correlated with filiform leaves in group I. in *E. gregatum* and *E. barba-caprae*, and in group VIII in a series beginning with *E. breviscapon* and ending with *E. fluvatile*; while in group II it is accompanied by a great lengthening of the stem.

This work was only rendered possible by the kindness of the officers in charge of the herbaria in the Royal Botanic Gardens, Calcutta (which has most of the types); the Agricultural College, Coimbatore; the College of Science, Poona; the Forest College, Dehra Dunn; and the Royal Botanic Gardens, Peradiniya, in placing their material at my disposal for examination, and to them my thanks are due and warmly tendered; but particularly to Lt.-Col. A. T. Gage, the Director of the Botanical Survey of India, and Superintendent of the Royal Botanic Gardens, Calcutta whose collection is the largest and contains most 'types'.

Explanation of the Figures

Fig. 1.	Male flower of		*E. quinquangulare* L.
Fig. 2.	Female flower of		*E.* do. do.
Fig. 3.	Do.	do.	*E. trilobum* Ham.
Fig. 4.	Male	do.	*E. caulescens* Steud.
Fig. 5.	Female	do.	*E. Eleanoræ* sp. nov.
Fig. 6.	Do.	do.	*E. minutum* Hook.
Fig. 7.	Do.	do.	*E. Thomasi* sp. nov.
Fig. 8.	Do.	do.	*E. alpestre* Hook. f.
Fig. 9.	Male	do.	*E. horsley-kundæ* sp. nov.
Fig. 10.	Do.	do.	*E. Sieboldianum* Sieb. et Zucc.
Fig. 11.	Female	do.	*E.* do. do.
Fig. 12.	Head of	...	*E. Dianæ* sp. nov.
Fig. 13.	Do.	...	*E. roseum* sp. nov.

CONTRIBUTIONS TOWARDS A FLORA OF BALUCHISTAN.

From materials supplied by Col. J. E. B. Hotson, I. A. R. O.

BY

E. BLATTER, S. J., P. F. HALLBERG AND C. MCCANN.
St. Xavier's Coll., Bombay.

Ranunculaceae.

CLEMATIS *L.*

Clematis orientalis *L. Sp. Pl. 765.* Loc.; Sitani, 28° 19′ N, 66° 5′E (no. 367, 367 A), about 5,300 ft. 20-VI-18.

ADONIS *L.*

Adonis aestivalis *L. Sp. Pl. 771.* Loc.: Panjgur, about 3,100 ft. (no. 155), Garmkan, about 6 miles NE of Panjgur, about 3,125 ft. (no. 155A). Fl. and fr. in March 1918. *Vern. Name*: Buchki (Bal. Brah, ?).

RANUNCULUS *L.*

Ranunculus aquatilis *L. Sp. Pl. 781* (partim) var. submersus *Gr. and Godr.* Loc.: Sitani, 28° 19′ N, 66° 5′ E, about 5,300 ft. (no. 365, and 365A), "at places the irrigation channels were starred with these flowers, like tiny water lilies." (Hotson). Fl. and fr. in June 1918.

Ranunculus muricatus *L. Sp. Pl. 780.* Loc.: Panjgur, about 3,100 ft. (no. M 154). Fl. and fr. in March 1918. *Vern. Name*: Kalafs (Bal.).

Ranunculus pseudo-muricatus *Blatt. and Hall. spec. nov.* Acaulis, humilis, glaber; folia omnia radicalia, longe-petiolata petiolo 20 mm longo, suborbiculata subreniformia, 13 mm diametro, breviter triloba lobis grosse obtuse-dentatis. Pedunculi foliis breviores, florigeri 10 mm, fructiferi vero 20 mm longi. Flores flavi; calyx patens sepalis ovatis acutis apice contortis (in herbario tantum?); petala late-oblonga, obtusa, sepalis brevioria. Carpella ca 7, rotundo-ovata; rostrum disco brevius, recurvum; margo rostrumque carpellorum viridia, sulcata; discus brunneus, punctulatus spinis ca 6 curvatis obsitus partem praesertim apicalem et ventralem occupantibus.—This species is distinguished from R. muricatus by being stemless and quite glabrous, by the patent calyx, by the shape and size of the petals, and by the sepals not being setulose. Loc.: Nag (W. Kolwa), about 83 miles E. by N. of Turbat, about 2,300 ft. (no. 154 A). Fl. and fr. in April. 1918. *Vern. Name*: Kalafs (Bal.)

Ranunculus arvensis *L. Sp. Pl. 780.* Loc.: Khudabadan, ¼ mile N. of Panjgur, about 3,100 ft. (no. 182). Fl. in March 1918. *Vern. Name*; Zard Phul (Bal.).

Menispermaceae.

COCCULUS *DC.*

Cocculus cebatha *DC. Syst. I (1818) 527.* Loc.: Kanoti, 47 miles N. of Las Bela, about 3,200 ft. (217A); W. side of Burida Pass, 140 miles SSW of Kalat, below 4,250 ft. (no. 217). "Every time I have seen this plant it has been growing out of a rock and hanging down the face of a cliff." (Hotson). 5-X-17 and 30-VIII-17. Uses: Is reputed to make water cold and to thicken it (Hotson). *Vern. Name*: Zamor (Bal., Br.).

Cocculus villosus *DC. Prodr. I. 98.* Loc.: Baran Lak, 28 miles S. of Wad, about 3,900 ft. (no. 380). Fl. in Oct. 1917.

Berberidaceae.

BERBERIS *L.*

Berberis lycium *Royle III 64.* Locality not given.

Berberis vulgaris *L. Sp. Pl. 472.* Loc.: Harboi, 18 miles ESE of Kalat, 9,000 ft. (21 A,B,C). Fruit ripening about the time of the wheat harvest in the valleys, say June in these parts or early July. Uses: The small red berries are eaten by men and animals. The roots are boiled and give a decoction good for fever, especially high fever; it is said to make the chest "narm". (Hotson). *Vern. Name*: Zarch Brah.

Papaveraceae.

Hypecoum pendulum *L. Sp. Pl. 181.* Loc.: Khudabadan, ¼ mile N. of Panjgur, about 3,100 ft. (no. 191); Garmkan, 1 mile NE of Panjgur, about 3,125 ft. (no. 167). Fl. and fr. in March 1918.

Fumariaceae.

FUMARIA *L.*

Fumaria parviflora *Lam. Encycl. II (1786) 567.* Loc.: Panjgur, about 3,100 ft. (no. M 173); Khudabadan, ¼ mile N of Panjgur, about 3,100 ft. (no. M 180); Fl. in March 1918—Fr. in March 1918. *Vern. Name*: Kankechk (Bal.), Kahurkah? (Bal.)

Cruciferae.

ARABIS *L.*

Arabis sp. prope **A. tibeticam** *H. f. & T.* Loc.: Rakhshan river bed at Panjgur, about 3,100 ft. Fl. and fr. in March 1918 (no. 16).

Arabis sp. prope **A. purpuream** *Sibth. & Sm.*—Fructus immaturus. Loc.: Khudabodan, ¼ mile N. of Panchgur, about 3,100 ft. (no. 157 B). Fl and fr. in March 1918. *Vern. Name*: Grabust (Br. and Bal).

BARBAREA *R. Br.*

Barbarea plantaginea *DC. Syst. II, 208.* Loc.: Rakhshan river bed at Panjgur, about 3,100 ft. (no. 160). Fr. in March 1918.

FARSETIA *Turra.*

Farsetia Jacquemonti *Hook. f. and T. in Proc. Linn. Soc. v. 148.* Loc.: Panjgur (no. M. 336). Fr. in May 1918.

Farsetia ageyptiaca *Turr. Diss. p. I, tab I.* Loc.: Garmkan, 1 mile NE of Panjgur, about 3,125 ft. (no. 165). Fl. and fr. in March 1918.

Farsetia sp. Fortassis specimen nanum *Farsetiae Hamiltonii* Royle. Loc.: Dokop 10½ miles E of Mand, about 650 ft. (no. 67). Fl. and fr. in March 1918.

Farsetia sp. Loc.: Manguli, 26° 45′ N, 65° 21′ E, about 2,600 ft. (no. 291). Fl. in April 1918.

Farsetia sp. Loc.: Kuldan (W. Kolwa), about 85 miles E. by N. of Turbat about 2,400 ft. (no. 244). Fl. Just coming out in April 1918. *Vern. Name*: Alant (Bal.).

Farsetia sp. Loc.: Nag (W. Kolwa), about 83 miles E. by N. of Turbat, about 2,300 ft. (no. 241). *Vern. Name*: Kular.

MALCOLMIA *R. Br.*

Malcolmia africana *R. Br. Kew. IV. 121.* Loc.: Not given.

Malcolmia Bungei *Boiss. Fl. Or. 1. 226.* Loc.: Khudabadan, ¼ mile N. of Panjgur, about 3,100 ft. (no M 188). Fl. and fr. in March 1918. *Vern. Name*: Jadanik, Sochaku (Bal.).

GOLDBACHIA *DC.*

Goldbachia hispida *Blatt. & Hall. spec. nov.* Herba annua (?) glauca, 20 cm alta, a basi ramosissima, radice simplici, caule striato glabriusculo. Folia radicalia petiolata spathulata integra 4 cm longa, caulina oblanceolata—obtusa vel linearia obtusa basi breviter auriculata, margine remote et breviter hispido, costa media inferiore prominente. Flores racemos terminales ebracteatos, multiflores laxos formantes, minimi, (petalis roseis uti videtur); pedicelli ca 2 mm longi, floribus subaequilongi, filiformes, fructificantes incrassati reflexi 5 mm longi. Siliqua unilocularis indehiscens, monosperma 6 mm longa, vel disperma 9 mm longa, inter semina contracta, coriacea turgidal 2 mm lata basi attenuata, apice in stylum triangularem planum obtusum contracta, cujus margines decurrunt secus siliquæ latera; facies siliquae costa media plus minusve distincta ornatæ, interdum prominenter reticulatæ et bituberculatae si siliqua est monosperma, vel tetratuberculatae si siliqua est disperma; tuberculis presentibus constrictio inter semina minus distincta. Sumina anguste oblonga, subcylindrica, faciebus oppositis sulcata.—This species differs from Goldbachia laevigata in the following points: The margin of the leaves is hispid, the siliqua is sometimes 1-seeded, never 3-seeded, the siliqua shows distinct dimorphism. Note: As there is no doubt that this species belongs to the genus Goldachia, a slight change in De Candolle's diagnosis of the genus should be made. He says that there are 2 or 3 cells in the siliqua, superimposed in one row. According to the present knowledge of the genus we must say that there are 1-3 cells in the siliqua. Loc.: Harbud, about 55 miles E of Panjgur, about 3,700 ft. (no. 247 A). Fl. and fr. in April 1918. *Vern. Name*: Kularbahar (Bal.).

SISYMBRIUM *All.*

Sisymbrium Sophia *L. Sp. Pl. 922.* Loc.: Khudabadan, ¾ mile N. of Panjgur, about 3,100 feet (no. M. 181), Kalat, about 6,350 ft. (no. 395). Fl. and fr. in March 1918. Fr. in July 1918, at the higher locality. *Vern. Name*: Kahurkah (? Bal.).

Sisymbrium thalianum *Gay & Monn. in Gaud. Helv. IV. 348.* Loc.: Nagak (W. Kolwa), about 87 miles E by N. of Turbat, about 2,400 ft. (no. 138 A). Fr. in April 1918. *Vern. Name*: Baharo (probably wrong according to Hotson).

BRASSICA *L.*

Brassica campestris *L.* Loc.: Nal, 27° 41′ N, 66° 13′ E, 3,834 ft., probably only from an accidentally dropped seed, a mile or more from any water in a barren stony plain (no. 337). Fl. in September 1917. *Vern. Name*: Mashna Muli (Brah.)

ERUCA *DC.*

Eruca sativa *Lam. Fl. Fr. II. 496.* Loc. not given. Fl. and Fr. in August 1917.

CAPSELLA *DC.*

Capsella bursa pastoris *Moench. Meth. 271.* Loc.: Rakhshan river bed at Panjgur, about 3,100 ft. (no. 115 A). growing in a dry stony river bed. *Vern. Name*: Halaku (Bal,).

LEPIDIUM *L.*

Lepidium draba *L. Sp. Pl. 645.* Loc: Mazarjuh, about 28° 11′ N, 69° 2′ E. about 5,200 ft., found among wheat stubble (no. 157 E); Teghab, 107 miles S. of Kalat, about 4,150 ft. (no. 184); Panjgur, about 3,100 ft. (no. M 157); Harbud (no. 157-C); Kochau, 122 miles SSW of Kalat, 4,150 ft. (no. 184 A); Harbud in Gichk, about 55 miles E. of Panjagur, about 3,700 ft. (no. 157 C). Fl. in March and April 1918. Uses: Cooked and eaten like "palak" or spinach *Vern. Name*: Garbust (Bal. Br.). "Garbust seems to be a general name for various edible plants with little else in common." (Hotson).

Lepidium propinquum *F. & M. in Hohen. Talysch Enum.* 142. var. *auriculatum* Boiss. Fl. Or. I. 357. Loc. not given. Fl. in Aug. 1917.

Lepidium sp. Loc.: Hazarganji, 27° 28′ N. 66° 12′ E, about 3,600 ft. (no. 184 B). *Vern. Name*: Garbust (Bal. Br.).

ISATIS *L.*

Isatis latisiliqua *Stev. Mem. Mosq. III (1812) 267.* Loc.: Mitasing, about 17 miles ESE of. Panjgur, about 4,000 ft. (no. 318, 318A). Fl. and fr. in April 1918. *Vern. Name*: Karkikah (Br.).

Isatis minima *Bunge Del. Sem. Hort. Dorp. (1843) 7.* Loc.: Harbud, about 55 miles E. of Panjgur, about 3,700 ft. (no. M 312). Fl. and Fr. in April 1918. *Vern. Name*: Khulif (Br.).

PHYSORHYNCHUS *Hook.*

Physorhynchus brahuicus *Hook. Ic. Pl. tab. 821 and 822.* Loc. Cracks in rocky sides of Anjiri, hills S. of Chambar (Kolwa), 26° 9′ N.

64° 42′ E, 1,900-2,200 ft. (no. 266, 266A, 266B). Fl. and fr. in April 1918. Note: The lower joint of the siliqua contains sometimes one seed, each loculus of the upper joint is either seedless or 1-seeded.

Capparidaceae

Cleome *L.*

Cleome brachycarpa *Vahl in DC. Prodr. 1. 240.* Loc.: Zahren Kahur, 16 miles N. of Pasni, about 200 ft. (no. M. 38); Rari Dan, 170 miles S. by W. of Kalat, 2,300 ft. (no. 286); Korak Pelar, 180 miles S. by W. of Kalat, 1,900 ft. (no. 279). Fl. and fr. in Sept. 1917. Uses: The leaves are said to be crushed in oil and rubbed on the arms, etc., as an embrocation for high fever (Hotson). *Vern. Names*: Miskok (Bal.), Pawal (Brah.).

Cleome Hotsonii *Blatt. & Hall. spec. nov.* Herba perennis, basi lignosa, glauca, glaberrima, caulibus gracilibus ascendentibus, 25 cm altis, angulosis. Folia uniformia, elliptica, obtusiuscula, subobliqua, basi subacuta, valde obscure trinervia, carnosa, remote sparsa, infima maiora 25 mm attingentia (petiolo incluso), longepetiolata petiolo gracillimo tertiam vel dimidam partem laminae attingente, superiora minora, floralia (bracteae) minima. Racemi terminales, pauciflori, laxissimi. Pedicelli patentes fructiferi 8 mm longi, florigeri breviores. Calyx minutissimus, divisus paene ad basim, lobis ovatis, acutis, reticulatim venosis duobus tribus aliis longioribus. Petala 4, longa 7 mm, apice subulata, trinervia. Stamina 6 diversae longitudinis, petalis breviora. Gynophorus, ovarium necnon stylus in nostris speciminibus valde obscura (an rudimentaria ?). Siliqua pendula, linearis, recta, utrimque attenuata, 65 mm longa, $2\frac{1}{2}$ mm lata, aliquantulum compressa, membranacea, striata, stipite gracili 4 mm longo, apice cuspidata. Semina disciformia lanata, margine obtusa. This species comes nearest to C. glauca DC., but is distinguished by the following points: The petioles are much longer, the leaves are elliptic not ovate, the siliqua has a sharp cusp, is longer and narrower. Loc.: Hills near Ispikan, about 20 miles NE of Mand, 1,200—1,500 ft. (9 0, 90 A). Fl. and fr. in March 1918. *Vern. Name*: Shwanko (Bal.). "The name was given doubtfully" (Hotson).

Maerua *Forsk.*

Maerua crassifolia *Forsk Fl. Aegypt. Arab. p. 113.* Maerua uniflora *Vahl.* Loc.: Hodal Pass (N. side), about 80 milee S. of Panjgur, 2,200—2,900 ft. (no. M. 15 B); Nasirabad, 23 miles W. of Turbat, about 400 ft. (no. M 15 B). Common on both side of the Hodal Pass which leads from Kilkaur to Kolwa. Fl. in April 1918. *Vern. Name*: Jogar (Bal.).

Capparis *L.*

Capparis decidua *Pax in Engl. Prantl Nat. Pflanzenr. III, 2, p. 231.*—C. aphylla *Roth.* Loc.: Jatu Pass (S. side), about 36 miles S. by W. of Panjgur, 3,250 ft., comparatively uncommon in this neighbourhood (no, M 64 A); W. side of the Burida Pass, from Bhani

to Jebri, fully 140 miles SSW of Kalat, below 4,250 ft. (no. 218); Rek Chah 11 miles E. of Chamber (Kolwa), about 1,800 ft. (no. M 64B, 64C); throughout the Kolwa plain the chief feature of the landscape is the vast number of Kaler trees, all in flower (13-IV-18). The shades vary from pale salmon to deep red, but the general aspect is far more autumnal than spring-like; Siman river, 15 miles SE of Khozdar, about 3,700 ft. (no. 218, A bis); 2 miles W. of Tump i.e. 48 miles W. of Turbat, about 600 ft. (no. M 64). Fl. and fr. in March 1918, April 1917 and 1918, Sept. 1917. Uses: The fresh young twigs (tips only) are crushed and soaked in water. The water is strained off—sometimes this is done two or three times. The residuum is dried and allowed to solidify. A tiny piece of it is eaten with butter and gives relief from pain after a bruise or fall. Also makes a very strong plaster. (Hotson). *Vern. Name*: Kalir (Bal.), Kaler (Br.).

Capparis spinosa *L. Sp. Pl. 720.* Loc.: On SE side, near summit, of Gar Pass betweeen Rakhshan and Grichk valleys, about 22 miles ESE of Panjgur, about 4,200 ft. (no. M. 286, 28 C). Fl. and fr. in April 1918. Uses: The berries are crushed; they give a lot of juice, but if they are dry, a very little water is added, and the juice is poured, not heated, into the ear as a cure for ear-ache. (Hotson). *Vern. Name*: Krap (Bal.).

Capparis spinosa var. **canescens** *Coss. Not. pl. Crit. I, 28.* Loc.: Gar Pass, about 22 miles E. by S. of Panjgur, about 4,200 ft. (no. 28 B, 28 D); hills near Ispikan, about 20 miles NE of Mnad about 1,200—1,500 ft. (no. 28A); Ornach, 3,080 ft. (no. 140A); Kuldan (W. Kolwa), about 85 miles E. by N. of Turbat, about 2,400 ft. (no. M 246); near Korak (Pelar), 180 miles S. by W. of Kalat, 1,900 ft. (no. 281); Gwambuk, about 50 miles S. by E. of Panjgur, about 2,700 ft. (no. M 28). Fl. in April 1918. Fr. in April 1918. Uses: Used as medicine for goats. The leaves are very bitter (Hotson). *Vern. Names*: Krap (Bal.), Karap (Br.), Khaf Khandar (Br. Bal.)

Capparis spinosa var. **parviflora** *Boiss. Fl. Or. I, 420.* Loc.: Kalgali Kaur, N. of Zayaki Jangal, about 4,800 ft. (no. M 28F). Shadadzai, 72 miles S. of Kalat, 5,100 ft. (no. 140). Fl. in Aug. 1917. Uses: Is boiled in water and applied as a poultice for boils. Also makes water cold. (Hotson). *Vern. Names*: Krap (Bal.), Khalkandir Khafkhandar (Br.).

Resedaceae.

OCHRADENUS *Del.*

Ochradenus baccatus *Del. Fl. Eg. 15, tab. 34, fig. I.* Loc.: Dokop, 60 miles W. of Turbat, about 700 ft. (no. M 17); junction of Raghai and Sichk rivers, about 3,600 ft. (no. M 307); Taloi Sunt, about 50 ft. (M 17B); Hazarganji, 27° 28′ N, 66° 82′ E, about 3,600 ft. (no. 334). Fl in Feb. 1918, April 1918, Sept. 1917, Dec. 1917. Uses: The twigs, leaves and flowers are fried, ground to a powder, mixed with a little neshar and applied dry to wounds and sores to kill maggots, etc. (Hotson). *Vern. Names*: Kalir Ram, Kirmkush (Bal.).

(*To be continued*).

CURRENT LITERATURE.

New Indian Species, etc.

Meteoromyrtus *Gamble gen, nov. Kew Bull. 7 (1918) p. 241.* Separated from *Eugenia* Linn. in which the one species *M. wynaadensis* had been placed by Beddome chiefly because the ovules are about 4 and pendulous from the apex of the ovary.

Pygeum sisparense *Gamble sp. nov., l.c. p. 238*, allied to *P. acuminatum* Colebr. but differing in smaller leaves, shorter racemes and fewer stamens. *Dist.* In forests on the south-west side of the Nilgiri plateau about Sispara at 6,000 to 7,000 ft.

Eugenia discifera *Gamble sp. nov., l.c. p. 239* allied to *E. caleadensis* Bedd. But differing in having no peduncles and short pedicels and the dry leaves somewhat gray below. *Dist.* near Chimunji, Travancore about 4,000 ft.

Jambosa Bourdillonii *Gamble sp. nov., l.c. p. 239* allied to *Eugenia hemispherica* Wight, but differing in the nervation of the leaves being conspicuous on the under side, the very short cymes and the campanulate calyx tube. *Dist.* Travancore about 2,000 ft.

Jambosa courtallensis *Gamble sp. nov , l.c. p. 239*, a distinct species somewhat like *Eugenia Mundagam* Bourdillon in the nervation of the leaves, but differing in the leaves being much smaller and rounded, not cordate at the base, and in the elongated subcylindrical calyx tube. *Dist.* Courtallum, Tinnevelly Hills.

Syzygium palghatense *Gamble sp. nov., l.c. p. 240* allied to *S. calophyllifolia* Walp., but differing in the obovate (abruptly) obtusely acuminate leaves and elongate infundibuliform calyx. *Dist.* Palghat Hills, Malabar about 5,000 ft.

Syzygium travancoricum *Gamble sp. nov., l.c. p. 240* closely allied to no other species and distinguished by its long petioled leaves and small flowers in long-peduncled long-branched cymes. *Dist.* In swampy places in the low country of Travancore up to about 200 ft.

Osbeckia lineolata *Gamble sp. nov., l.c. p. 241*, allied to *O. minor* Triana but differing in the leaves which are larger, elliptic, setoso-mucronate and drying yellow; and in the larger flowers and fruit. *Dist.* Nilgiris and Pulneys about 6,000 to 7,000 ft.

Osbeckia courtallensis *Gamble sp. nov., l.c. p. 242*, although similar to *O. Kleinii* W. and A, in the setae of the calyx, yet differing in the smaller, elliptic, lanceolate leaves, and few flowered inflorescence. *Dist.* Courtallum, Tinnevelly.

Osbeckia Lawsoni *Gamble sp. nov., l.c. p. 242* allied to *O. Kleinii* W. & A., but differing in the acute calyx lobes and smaller leaves. *Dist.* Travancore at about 2,000 ft.

Ixora Butterwickii *Hole sp. nov., Indian Forester XLV (1919) No. 1 p. 15*, allied to *I. spectabilis* Wall and *I pendula* Jack, but differing from the former in the larger size and shape of the leaves, more numerous lateral nerves and wider panicle, and from the latter in the shorter corolla tube, longer anthers and wider panicle. This species is at present known only in Burma.

Anogeissus rotundifolia *Blatter and Hallberg sp. nov. Journ. Bombay Nat. Hist. Soc. XXVI (1919) No. 2 p. 525*, differs specifically from *A. coronata* Straf in Kew Bull. 4 (1914) p. 153. *Dist.* Kailana near Jodhpur.

Pulicaria rajputanae *Blatter and Hallberg sp. nov., lc. p. 535*, allied nearly to *P. crispa* Benth., but differing in the following points: the plant is woolly all over, the margin of the leaves is not recurved, the ligules are much longer than the bracts, the pappus is six times as long as the achenes. *Dist.* Jodhpur and Jaisalmer. Flowering and fruiting in October and November.

Glossocardia setosa *Blatter and Hallberg sp. nov., lc. p. 536*, distinguished from *G. linearifolia* Cass. by the following characters: the plant is much larger and generally erect, the shape of the outer bracts is different, the awns of the achene spread almost horizontally and are setose, sometimes half way up, at other times along their whole length. *Dist.* Jodhpur and Jaisalmer. Fruiting in October and November.

Convolvulus densiflorus *Blatter and Hallberg sp. nov., l c. p. 545* (near *C. rhyniospermum* Hochst), *Dist.* Jodhpur and Jaisalmer. Flowering and fruiting in October and November.

Convolvulus gracilis *Blatter and Hallberg sp. nov., lc. p. 545. Dist.* Jodhpur. Flowering and fruiting in November.

C. T.

Distribution of Phanerogams

Guppy, H. B., Plant-Distribution from the Stand-point of an Idealist. *Jour. Linn. Soc. XLIV No. 299 (July 1919) pp. 439-472.*

It would probably not be a mis-statement to say that in regard to the origin of species and to evolution in general, the vast majority of Botanists as well as Zoologists are divided into two camps, the Darwinians who believe in progressive evolution by small changes, and the Mutationists who contend that specific differences are often, or perhaps always, caused by sudden changes; and to this camp belong also those who pin their faith on the transmission and acquirement of characters on Mendelian lines. But as far as the writer of this notice is aware in neither camp would it be denied that generic differences have in the past arisen out of smaller (specific) beginnings, and have in turn led to the larger differences which separate the orders or families as we know them to-day. Mr. Guppy in the paper under notice contends that the present distribution of the families of plants, the great majority (over 70 per cent.) of which occur in both the Old and the New World, points to an even distribution in some bygone age over the whole globe; an age when conditions where much more uniform than at present and when first the larger groupings then the families were segregated. The splitting up of these families into genera and then into species followed in another era when climatic differentiation had become established. In other words evolution has been not from small differences growing into larger, but by the laying down first of the major lines of cleavage between plant groups, and the subsequent splitting up of those groups into smaller ones.

In a series of tables at the close of the paper it is shown that the idea usually held that the junction in the north of the two great land masses of America and Eurasia has afforded opportunity under suitable climatic conditions for a mixing of the floras of these two areas, is not borne out by statistical evidence in the case of the families, only partly so in regard to the genera, but much more so with the species. It is also shown that while the majority of families ignore in the distribution the existence of the ocean barriers between these two parts of the land, they are very much affected by

the climatic zonation. Also that of the different great groups of the Flowering plants the Monocotyledons are predominantly tropical, the Sympetalæ least so, and this lagging behind by the Monocotyledons in escaping from the tropics may perhaps be explained by the vastly greater proportion of aquatic orders in this group, though this is probably not the whole explanation.

The paper begins with a reference to papers on the distribution of the Compositæ, by Bentham and of Gentianaceæ by Huxley, in both of which an original even distribution of the family was postulated and the work of Dr. Willis on the Podostemaceæ, which in spite of absolutely uniform conditions show the greatest amount of floral and other differentiation is quoted as lending support to the idea that in an age of great uniformity of conditions it might be possible to have the greatest instability of essential characters, which later on became fixed with the gradual progressive differentiation of conditions.

P. F. F.

Ecology

Sedgwick, L. J., Analyses of some morphological characters of Bombay woody species from an Oecological stand-point. *Indian Forester 1919 pp. 193—9.*

This paper arose the author says 'from a desire to test the 'drip-tip' theory of Stahl' but he included investigation on armature and methods of seed-dispersal. 'The leaf-tip he classifies under seven heads from 'very long acuminate to very obtuse with an eighth class of plants leafless in the mature state, for xerophytes. Acute or acuminate tips are a feature of the evergreen forests of his region (with 83 per cent.), but among xerophytes there are 35 per cent. not much fewer than with obtuse apices (41 per cent.); and the author believes the acuminate leaf-apex is only the result of general good development owing to favourable circumstances at the end of the chief vascular bundle. Thorns and spines too he finds chiefly developed among xerophytes but also in some evergreen trees, and since goats and camels eat thorny Acacias without seeming to mind the thorns, he denies in this case too any teleological explanation, and puts down the hardening of the thorns simply to the tendencies of general development. To this most people will probably agree, for that the development of spines and prickles is furthered, and even initiated, by dryness has been proved by Lothelier with *Ulex*, and by other workers.

P. F. F.

Histology

Balls, W. L., Growth-rings in the Cell Wall of Cotton Hairs *Proc. Rag. See B. 90 No. B 634, p. 542* with 4 text-fig and 5 microphotographs.

By suitable treatment of cotton hairs to make the wall swell, the author demonstrates the existence of concentric layers, corresponding to the daily growth in thickness of the cell-wall interrupted as it is each afternoon by the sun-heat. Previous work had shown that the growth in thickness of the wall, and the formation of simple pits began on 21st to 25th day of the

formation of the fruit, and the author had before been led to the conclusion that growth in thickness took place every night, and might be expected to show itself in about 25 concentric layers. The process and methods now described prove this supposition correct. Owing to the thinness of the wall each layer is only about 0·4 μ in thickness, or less than the wave length of yellow light. Hence the necessity for a very considerable swelling of the hair, but with the proper treatment as above the stratification could be seen with a $\frac{1}{8}$ inch objective.

P. F. F.

Osterhout, W. G. V. Tolerance of fresh water by Marine plants and its relation to adaptation *Bot. Gaz. 63; 146-149; 1917.*

Osterhout points out "the remarkable differences between marine plants and even between different cells of the same plant with respect to their tolerance of fresh water" and gives an interesting discussion on the theory of adaptation. *Polysiphonia violacea* is given as an instance where death takes place with great rapidity on transference to fresh water. Various others, representative of the red, brown, green and blue green algæ showed extreme tolerance of fresh water. One particular instance is, where, at the mouth of a brook, all kinds of algæ were exposed alternately to 6 hours of fresh water and 6 hours of salt water between the tides. *Zostera maritima* is found in places where the roots are constantly in salt water while the leaves are alternately under salt and fresh water. It is found that the roots of this plant die in a few minutes in fresh water. This difference between the roots and leaves is in accordance with the theory of adaptation as the leaves under such conditions will be expected to be more tolerant of fresh water than the roots. But the same differences between roots and leaves are also found in plants of the same species growing constantly in sea water "where no opportunity for adaptation to fresh water occurs." The author remarks "that characters which seem to be the result of adaptation were in this case present from the beginning and must be ascribed entirely to different causes."

T. E.

Heredity.

Bateson, W., Studies in Variegation—*Journal of Genetics VIII No. 2. (April 1919) pp. 93—98 3 col. pl.*

The author draws attention to the two forms of variegation due to deficiency of chlorophyl in (*a*) the skin a epidermal layer, so that there is a white skin on a green core, and in (*b*) the middle of a leaf, so that there is a green skin over a white core. This last is much less common than the other. Variegated plants of the first kind, however fertilised, always give white or albino offspring which of course do not live long. The leaves have usually a white edging and green centre. In the second kind the leaves have a green edging and pale centre.

Two instances were noticed of a reversal *i.e.*, of a variegated plant of the kind (*a*) bearing a shoot of (*b*). These were in variegated varieties of *Euonymus japonicus* and *Pelargonium.*

Variegated plants though not of these genera are so commonly grown in our Indian gardens and are so easily propagated, that it seems worth while suggesting an examination of the plants in gardens, for other instances of reversal. Interesting problems of heredity are bound up with the inheritance of these chimaeras.

P. F. F.

Algae.

Bristol, B. M. Miss., On a Malay form of Chlorococcum humicola (Nag) Rahenbh. *Jour. Linn. Soc. Bot. XLIV, No. 299, (July, 1919) pp. 473—480, pl.*

A specimen of soil from Kajang, Malay States, which had been air-dried and stored for two years, was put in a suitable culture-fluid, and after some eight months an alga was found which soon developed quite healthily and proved to be in no way different from the English *Chlrococcum humicola.*

Germination was certainly slower, and the cells larger, but the author points out that the size varies in the cultures a very great deal, cells being measured from 20 to 80 μ in diameter. The formation of both zoogonidia and of aplanospores was observed, and in the former an abnormal form seen where owing to the liberation of the zoogonidia before the division had been completed, a triangular body appeared with pairs of cilia at the three corners. The author explains the palmella stage which follows the formation of aplanospores as idicating that the latter are "really reduced zoogonidia, but that the surrounding nutrient conditions are such as to be able to support the development of a large number of individuals in a small space, and to render their wider distribution unnecessary," a teleological explanation which seems hardly sufficient to account for the palmella stage. As illustrating the extraordinary resistance of the spores to desiccation the author gives her experience with samples of soil which were collected as long ago as 1846, and 1856 from a plot at Rothamstead. From the former she did not obtain any growth, but did from the latter, which shows that the limit of retention of vitality lies between 70 and 80 years.

P. F. F.

Printed and Published for the Proprietor by W. L. King at the Methodist Publishing House, Mount Road, Madras.

THE
Journal of Indian Botany.

VOL. I. NOVEMBER, 1919. No. 3.

THE PHYSIOLOGICAL ANATOMY OF THE PLANTS OF THE INDIAN DESERT

BY

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(Continued from last issue.)

Cleome brachycarpa *Vahl.* Figs. 13, 14, 19, 20, 21. Herbaceous. Front cavity of stomata on a level with the surface. Guard-cells a little above the plane of the surrounding cells. Mesophyll isobilateral. Some of the palisade cells with tanniniferous contents. Middle tissue of the mesophyll formed of large colourless parenchymatous cells. Veins provided with colourless sheaths. Glandular hairs multicellular and capitate. Outer walls of the epidermal cells of the axis granulated. Axis ribbed. Pericycle formed of large thin groups of stone-cells. Assimilatory tissue in the axis consisting of chlorenchyma. Wood composite. Soft bast forming a continuous ring. Pith formed of thin-walled cells.

Cleome viscosa *L.* Figs. 15, 16, 28. Herbaceous. Epidermis of the leaf formed of thin-walled cells. Guard-cells elevated a little above the plane of the surrounding cells. Front cavity of the stomata in a level with the surface. Mesophyll formed of palisade tissue on the adaxial side and of arm-palisade tissue on the abaxial side. Internal glands absent. Glandular hairs multicellular and capitate. Veins not provided with sheaths. Stone-cell groups of the pericycle triangular. Assimilatory tissue of the axis formed of chlorenchyma. Wood composite. Soft bast forming groups. Pith formed of thin-walled cells.

Gynandropsis pentaphylla *DC.* Figs. 22, 23, 24, 25, 26, 29. Herbaceous. Guard-cells a little elevated above the plane of the surrounding cells. Mesophyll formed of palisade tissue on the adaxial side and of spongy tissue on the abaxial side. Internal glands absent,

Veins provided with green sheaths. Glandular hairs multicellular and capitate. Epidermis of the axis two-layered. Pericycle formed of rhomboidal stone-cell groups. Wood composite. Soft bast forming a continuous ring. Pith formed of thin-walled cells.

Cadaba indica *Lam.* Figs. 30, 31, 32, 33, 34, 35. Woody. Outer walls of the epidermal cells of the leaf greatly thickened and papillose. Guard-cells in the plane of the surrounding cells. Mesophyll formed wholly of short palisade cells. Internal glands in the leaf in the form of parenchymatous cells with tanniniferous contents. Veins not provided with sheaths. Water-storing tracheids occurring at the terminations of the veins. Clothing hairs peltate. Glandular hairs absent. Outer walls of the epidermal cells of the axis superficially granulated and lateral walls thickened. Pericycle formed of rhomboidal groups of stone-cells. Wood forming a composite ring; soft bast forming a continuous ring.

Capparis decidua *Pax.* Figs. 27, 36, 37. Woody. Leaves occurring only on young shoots. Epidermis of the leaf and axis formed of vertically elongated highly thick-walled cells. Mesophyll isobilateral with an extensive middle tissue of parechymatous cells. Internal glands in the form of numerous cells with tanniniferous contents. Veins not provided with sheaths. Pits present in the epidermis of the axis. Assimilatory tissue in the axis formed of palisade cells. A ring, 1-2 cell thick, of sclereids occurring below the assimilatory tissue. Pericycle formed of rhomboidal groups of stone-cells. Wood formed of xylem bundles connected by strands of interfascicular wood-prosenchyma. Soft bast forming groups. Pith composed of thin-walled cells.

Structure of the Leaf

Epidermis.—Outer walls are thickened and somewhat papillose in all members except *Cleome viscosa* (fig. 16.) The thickening and papillose differentiation is considerable in *Cleome papillosa* (fig. 11), *Cadaba indica* (fig. 30), *Gynandropsis pentaphylla* (fig. 22) and *Capparis decidua.* Lateral walls are thin in all the numbers except *Capparis decidua*, where they are thickned; they are somewhat undulate in all the members. Epidermal cells at the margin are rounded forming the marginal epidermis compact and rigid. Some of the lower epidermal cells in *Cleome brachycarpa* are larger and longer than broad, perhaps serving as water-reservoirs. Epidermal cells at the margin and along the mid-rib are smaller than in the other part of the leaf blade.

Stomata are surrounded by four to six ordinary epidermal cells (fig. 19) and are more numerous on the under surface. They are placed in depressions formed by the outer thickened and papillose

walls of the epidermal cells in *Cleome papillosa* (fig. 11), *Cadaba indica* (figs. 30, 31) and *Capparis decidua*, the guard-cells being situated in the plane of the surrounding cells. In the other members the guard-cells are elevated above the plane of the surrounding cells, so that the front cavity is on a level with the surface (figs. 23, 27.).

The mesophyll is composed of palisade tissue on the adaxial side in all the members and on the abaxial side of arm-palisade tissue in *Cleome viscosa* (fig. 16) or of spongy tissue in *Gynandropsis pentaphylla* (fig. 22). The mesophyll is isobilateral and is composed wholly of short palisade cells in *Cadaba indica* (fig. 30) or composed of palisade tissue on either side with a middle tissue of thin-walled colourless parenchymatous cells in *Cleome brachycarpa* (fig. 14) and *Capparis decidua*. The middle tissue in the former partakes in the formation of bundle-sheaths; and in the latter it is very extensive and forms perhaps a water-storage tissue. Internal secretory organs are of the nature of myrosin cells and are represented by (a) palisade like cells occurring in small groups on both sides below the epidermis in *Cleome viscosa* or (b) by parenchymatous cells in the middle tissue in *Cadaba indica* (fig. 30) and in *Capparis decidua* commonly occurring near the veins and quite numerous above the bundle of the mid-rib. The veins are embedded in all the members. They are provided with a sheath either of large colourless parenchymatous cells or of distinct green parenchymatous cells in *Cleome brachycarpa* (fig. 14) and *Gynandropsis pentaphylla* (fig. 22) respectively. Groups of large water-storing tracheids occur at the terminations of the veins in *Cadaba indica* (fig. 30 W). The vascular bundles of the mid-rib are arranged in the form of an arc with collenchyma on the lower side extending to the epidermis. The mid-rib projects on the lower side.

The hairy covering of the leaf and axis consists of (a) clothing and (b) glandular hairs.

(a) Clothing hairs are not unicellular in any of the members. *Cleome papillosa* and *Cleome brachycarpa* have shaggy hairs, the cells of which end superficially in sharp spiny apices (figs. 10, 11, 12). In *Cadaba indica* there are peltate hairs composed of a uniseriate stalk, much longer on the axis, and of a circular shield which in surface view presents a notched margin (fig. 33). Hairs are more numerous on the lower side of the leaf and especially on the mid-rib.

(b) Glandular hairs are present on the leaf and axis in all members except *Cadaba indica*. They are composed of a multicellular head irregularly divided (figs. 11, 13, 18). They are not numerous either on the leaf or axis; they are however more common

on the margin of the leaf. They are numerous and longer on the axis than on the leaf (fig. 26). In *Cleome brachycarpa* there are a few multicellular glandular hairs with a spiny curved apex (fig. 20).

Structure of the Axis

Epidermis consists of small cells with outer and inner walls thickened. Lateral walls are also thickened in *Cleome papillosa* and *Cadaba indica*. Epidermis is two-layered in *Gynandropsis pentaphylla*. Outer walls are superficially granulated in species of *Cleome*. Epidermis of *Capparis decidua* consists of vertically elongated small cells with outer walls greatly thickened and cuticularised. Epidermis of *Capparis decidua* is characterised by numerous small pits which in T. S. are bounded laterally by two ordinary epidermal cells and beneath by a curved cell. Viewed from the surface the pits resemble small square holes bounded by 4-5 cells. These pits may possess the function of stomata without any regulating apparatus. The axis of *Cleome brachycarpa* and *Cleome viscosa* is ribbed, the ribs being strengthened by collenchyma. In *Cleome brachycarpa* there are some large cells intercalated among the small epidermal cells of the ribs with perhaps partly a water-absorbing and partly a strengthening function.

The stomata are surrounded by 4-6 ordinary epidermal cells as seen in surface view. The front cavity is placed in a depression produced by the outer thickened epidermal walls. The guard-cells are in the plane of the surrounding cells. Stomata are replaced by pits in *Capparis decidua*, as described already.

Primary cortex is characterised by an assimilatory tissue composed of chlorenchyma, except in *Capparis decidua* where it is replaced by the palisade tissue. In *Capparis decidua* there are sclereids in a ring below the assimilatory tissue. The sclereids have thickened and radially striated walls and are characterised by pitted markings.

The pericycle is represented by groups of stone-cells, either thin and long as in *Cleome brachycarpa* and *Cleome papillosa*, or triangular as in *Cleome viscosa* or rhomboidal as in other species.

The structure of the wood can be seen from the following table. (p. 71.)

The soft bast forms a continuous ring as in *Cleome brachycarpa*, *Cadaba indica* and *Gynandropsis pentaphylla*, or forms groups as in other members.

The pith is either composed of thin-walled cells as in *Cleome brachycarpa*, *Cleome viscosa* and *Gynandropsis pentaphylla*, or of thick-walled cells, as in other species.

NAME OF THE SPECIES.	VESSELS.			WOOD-PROSENCHYMA		MEDULLARY-RAYS		GENERAL REMARKS.
	SIZE.	ABUNDANCE.	ARRANGEMENT.	SIZE.	ABUNDANCE.	SIZE.	ABUNDANCE.	
Cleome papillosa.	Small	Few	In groups of rows.	Large-lumen.	Not extensive.	1...... Seriate.	Few.	Wood composite.
Cleome brachycarpa.	Large	Numerous.	In groups of 2-4 rows.	"	" "	"	"	" "
Cleome viscosa.	"	Few	In groups of very incomplete rows.	"	Extensive.	Absent.	"	" "
Gynandropsis pentaphylla.	Small	"	In rows and projecting into pith.	"	"	"	"	" "
Cadaba indica.	"	"	In single rows and few.	Small	"	1...... Seriate.	Numerous.	" "
Capparis decidua.	Large	"	In very incomplete single rows.	Large	"	Absent.	...	Wood composite. Groups of sclerenchymatous cells at the lower end of the vessel-rows.

General Review:—Outer walls of the epidermal cells are thickened. Guard-cells are accompanied by ordinary 4-6 epidermal cells and are usually elevated above the plane of the surrounding cells. The mesophyll is either composed wholly of palisade tissue or is isobilateral, or is composed of palisade tissue on the adaxial side and of arm-palisade tissue or spongy tissue on the abaxial side. Internal secretory cells with tanniniferous contents are usually present in the leaf. The veins are embedded and are in some species provided with bundle-sheaths. Water-storing tracheids occur in the leaf and axis in some species. Mutlicellular capitate glandular hairs are of common occurrence. Peltate clothing hairs are present in *Cadaba indica*. Primary cortex is characterised by an assimilatory tissue composed either of chlorenchyma or of palisade tissue. The pericycle is composed of groups of stone-cells. The structure of the wood is composite. The soft bast forms a continuous ring or occurs in groups. The pith is composed either of thin-walled or of thick-walled cells.

VIOLACEAE.

Viola Stocksii *Boiss.*—Epidermal cells of the leaf and axis with inner walls gelatinised and with outer walls thickened and muriculate. Palisade-like elongation of the epidermal cells characteristic of the axis. Stomata present on both the surfaces. Guard-cells elevated above the plane of the surrounding cells. Mesophyll formed of palisade tissue on the adaxial side and of arm-palisade tissue on the abaxial side. Internal secretory organs absent. Oxalate of lime in the form of large clustered crystals in the leaf. Veins embedded and not provided with bundle-sheaths. Hairy covering absent. Sclerenchymatous pericycle absent. Wood composite. Vessels small and arranged in numerous complete rows. Medullary rays uniseriate Collenchyma occurring at the inner margin of the wood. Pith composed of thin-walled cells.

Structure of the Leaf:—The epidermis is composed of tabular cells, with outer walls thickened, muriculate and convexly arched outwards, and with inner walls gelatinised. Lateral walls are wavy. The marginal epidermal cells have outer as well as inner walls thickened. The gelatinised inner walls of the epidermis can absorb and retain water. The epidermis thus forms a kind of water-storing tissue. Stomata occur on both the surfaces. Guard-cells are elevated and are accompanied by subsidiary cells. The front cavity is on a level with the surface. The mesophyll is composed of palisade tissue on the adaxial side and of arm-palisade tissue on the abaxial side. Internal secretory organs do not occur either in the leaf or axis;

Numerous large clustered crystals of oxalate of lime occur in the arm-palisade tissue of the mesophyll. The crystals are wanting in the axis. The veins are embeded and are not provided with bundle-sheaths.

Both the leaf and the axis are devoid of hairs. The absence of hairs is compensated for by the gelatinisation of the inner walls of the epidermal cells.

Structure of the Axis :—Epidermis consists mostly of tabular cells with outer walls thickened, muriculate and convexly arched outwards. The inner walls are gelatinised and the lateral walls are straight. The epidermis is distinguished by two common features (1) palisade-like elongation of the epidermal cells in some parts (2) gelatinisation of the inner walls of the epidermal cells which are sometimes characterised by thin dividing walls parallel to the surface beneath which mucilage is found. The epidermis may occasionally serve as a water-storing tissue on account of these two features.

Cells of the outermost layer of the cortex show collenchymatous differentiation at their outer angles. The cortex is distinguished by the occurrence of cortical vascular bundles in the cortical chlorophyll containing parenchyma.

Sclerenchymatous pericycle is absent. The structure of the wood is composite. The vessels are small and are arranged almost in numerous complete rows. Interfascicular wood-prosenchyma is little developed. Medullary rays are uniserate and numerous. Small-celled collenchyma occurs at the inner margin of the wood. Soft bast forms a continuous ring.

The pith consist of thin-walled cells.

POLYGALACEAE.

Polygala erioptera *DC.*—Figs. 38, 39. Leaf and axis.—Numerous lysigenous cavities in the lower half of the mesophyll. Clustered crystals occurring near the veins. Compact bundles, comb-like at their ends, of diamond shaped bodies in the palisade-like cells in the upper half of the mesophyll. Epidermis of the axis two-layered. Axis ribbed. Ribs strengthened by stone-cell groups. Assimilatory tissue of the axis formed of palisade tissue. Sclerenchymatous pericycle in the form of groups of thick-walled and stratified bast fibres with small lumen.

Polygala irregularis *Boiss.*—Figs. 40, 41. Axis only.—Axis ribbed, groups of stone-cells strengthening the ribs. Epidermis one-layered. Assimilatory tissue composed of chlorenchyma. Aqueous cells between the groups of bast fibres. Sclerenchymatous

pericycle forming a loose ring of bast fibres. Oxalate of lime not occurring in any form.

Structure of the Leaf :—Epidermis in *P. erioptera* consists of tabular cells with outer and inner walls arched convexly outwards and inwards respectively. Outer walls are thickened ; lateral walls are thin and straight.

Stomata occur on both the surfaces of the leaf. The guard-cells are surrounded by ordinary epidermal cells and are situated in the plane of the surrounding cells (figs. 38, 41). The front cavity is arched over by outer horns of the guard-cells, which are quite prominent and come close together. The front cavity is placed in a depression formed by the outer thickened walls of the epidermal cells. Stomata on the axis (fig. 41) of both the species have the same characters as those on the leaf of *P. erioptera*. The mesophyll is composed of the palisade tissue on the upper side and of arm-palisade tissue on the lower. There are numerous lysigenously formed cavities in the arm-palisade tissue (fig. 38 L.C.) ; they may occasionally serve for storing water.

Oxalate of lime occurs in the form of clustered crystals near the veins of the leaves and in the assimilatory tissue of the axis of *P. erioptera* (figs. 38, 39). Besides the clustered crystals, there are elongated compact bundles of diamond shaped bodies, in the palisade tissue of the leaf; these bundles are comb-like at their ends on account of the projecting pointed ends of the diamond shaped bodies. As regards composition of these bodies, I cannot say anything. Oxalate of lime is not found in any form in *P. irregularis*.

Veins are few and are embedded; they are enclosed in bundle-sheaths of thin-walled colourless cells.

Hairy covering on the leaf and axis in both the species consists of unicellular thin-walled clothing hairs, either straight or hooked, and distinguished by knob-like thickenings on their walls. Glandular hairs are not found.

Structure of the Axis :—Epidermis is two-layered in *P. erioptera* while it is single layered in *P. irregularis*. Epidermal cells are tabular with outer-walls greatly thickened. Outer walls are convexly arched outwards in *P. irregularis*. Cuticle is thick, especially so in *P. erioptera*. Lateral walls are straight. The primary cortex functions as the assimilatory tissue and is composed of chlorophyll containing parenchyma in *P. irregularis* and of palisade tissue in *P. erioptera*. Groups of stone-cells occur in the ribs.

The pericycle is composed of a more or less continuous ring of bast-fibres, which are thickened, straitified and have a narrow lumen in *P. erioptera*. The ring is of uniform breadth in *P. erioptera*, while

in *P. irregularis* it is single layered on a small portion on one side, indicating the prostrate or inclined nature of the axis, sclerenchymatous pericycle being least developed on the lower side of the axis. There are thin-walled colourless cells between and on either side of some of the groups of bast-fibres in *P. irregularis*; they may occasionally serve as acqueous cells.

The wood is composite with vessels uniformly distributed in the interfascicular wood-prosenchyma. In *P. irregularis* the vascular ring is narrowed on the side where the sclerenchymatous pericycle is reduced; there are very few vessels in this portion which is mostly occupied by interfascicular wood-prosenchyma. This may be accounted for by the fact of less vigorous functional activity on the lower side of the prostrate or inclined axis of *P. irregularis.* Vessels are large and few and are arranged in incomplete rows. Medullary rays are usually uniseriate and numerous.

The pith is composed of very thin-walled cells.

CARYOPHYLLACEAE.

Polycarpaea corymbosa *Lam.*—Figs. 42, 43, 44. Epidermal cells of the leaves with outer walls thickened and papillose. Guard-cells accompanied by subsidiary cells. The front cavity greatly depressed in the axis. Mesophyll isobilateral. Abundance of cells with tanniniferous contents characteristic of the leaf and axis. Oxalate of lime in the form of clustered crystals. Assimilatory tissue in the axis formed of chlorenchyma. Pericycle composed of large groups of stone cells with a sclerenchymatous tissue on its outer side. Wood composed of large xylem bundles separated by strands of tissue, resembling medullary rays, continuous with the outer sclerenchyma. Large water-storing tracheids with reticulate markings in the xylem bundles near the medullary-ray-like strands. Pith formed of thick-walled cells.

Structure of the Leaf :—The epidermis consists of polygonal cells with outer walls thickened and papillose (fig. 42). The cuticle is smooth. The lateral and inner walls are thin and the former are wavy.

The stomata occur on both the surfaces and the guard-cells are accompanied by subsidiary cells. The guard-cells are elevated and the front cavity is placed in a depression formed by the papillose outer epidermal walls. The stomata on the axis are greatly depressed, as the guard-cells are situated below the surrounding cells (fig. 43). In addition to the subsidiary cells, there are sometimes found one or more cells clasping the guard-cells on one or both sides of the stomata on the axis (fig. 43).

The mesophyll is isobilateral and is composed of palisade tissue.

Internal secretory organs are represented by secretory cells with tanniniferous contents in the leaf and axis. In the leaf they are polygonal and lie in the lower half of the mesophyll. In the axis there is a sub-epidermal secretory tissue of one or two layers of tabular cells. Besides, there are numerous outer sclerenchymatous fibres and numerous pith cells with tanniniferous contents. Some of the cells of the medullary-ray-like strands also hold tanniniferous contents. The secretory cells with tanniniferous contents seem to be a characteristic feature of the species.

Oxalate of lime is abundantly found in the form of large clustered crystals near the veins in the leaf. In the axis cells with clustered crystals occur in the outer sclerenchymatous fibres, in the cells of the medullary-ray-like strands and in the pith.

The abundance of tanniniferous substance and of oxalate of lime in the leaf and axis gives an acrid taste to the tissues of the plant and makes it inedible by animals. Abundance of tannin also protects the tissue of the plant from desiccation. The veins are enclosed in green bundle-sheaths. Larger veins occur as usual in the middle of the mesophyll. Besides these, there are smaller veins near the lower epidermis. The vein of the mid-rib is protected above and below by strands of sclerenchyma and is vertically transcurrent below by colourless parenchyma.

The leaf and axis are devoid of clothing and glandular hairs.

Structure of the Axis :—The epidermis consists of small tabular cells with outer and inner walls very greatly thickened. Outer walls are convexly arched outwards. Lateral walls are straight. The cuticle is thick and smooth.

The cortex is characterised by a sub-epidermal tissue of tabular cells with tanniniferous contents. The assimilatory tissue which lies below the secretory tissue is composed of chlorophyll containing parenchyma.

The pericycle is composed of large groups of stone cells situated on the radii of the vascular bundles. Besides these pericyclic groups of stone cells, there is a tissue of sclerenchymatous fibres with larger lumina, continuous with the medullary-ray-like structures between the vascular bundles. There are a few scattered stone cells with walls much thickened and radially striated and with small lumina, on the outer margin of the sclerenchymatous tissue and in the soft bast.

The wood is composed of large xylem bundles separated by broad strands of radially elongated thick-walled cells resembling medullary-ray cells. These seem to be continuous with the sclerenchymatous tissue outside the pericyclic groups of stone cells.

There are isolated cases of sclerotic cells with canals, as large

To be inserted in the Journal of Indian Botany Vol. I No. 2 to face page 43.

Abbreviations used in the explanation of the plates.

Oc.—ocular.
Com.—compens ocular.
Ob.—objective.
Ap.—apochromatic.
T.S.—transverse section.
A—water-storing cell.
G.—internal gland cell.
L.C.—lysigenous cavities.
G.C.—secretory cavities.
Cl.—collenchyma.

Plate I.

1-2. *Cocculus Cebatha.*
1 T.S. of the leaf.
Oc. 6 Com.; Ob. 8 mm. Ap.
2 T.S. of the axis.
Oc. 8 Com.; Ob. 8 mm. Ap.
3-6. *Farsetia Jacquemontii.*
T.S. of the leaf.
Oc. 3 Com.; Ob. 3 mm. Ap.
4 Hair on the axis.
Oc. 2 Com.; Ob. 3 mm. Ap.
5 Stoma on the leaf.
Oc. 6 Com.; Ob. 3 mm. Ap.
6 T.S. of the axis.
Oc. 2 Com.; Ob. 3 mm. Ap.

N.B.—To get the original dimensions multiply by 1·7.

Plate II.

7-8 *Farsetia Jacquemontii.*
7 T.S. of the leaf.
Oc. 2 Com.; Ob. 3 mm. Ap.
8 T.S. of the axis.
Oc. 2 Com.; Ob. 3 mm. Ap.
9-12 *Cleome papillosa.*
9 Glandular hair on the leaf.
Oc. 1; Ob. C.
10 Glandular hair on the leaf.
Oc. 1; Ob. C.
11 T.S. of the leaf.
Oc. 2; Ob. C.
12 Hair on the axis.
Oc. 1; Ob. C.
13-14 *Cleome brachycarpa.*
13 Glandular hair on the leaf.
Oc. 1; Ob. 7.
14 T.S. of the leaf.
Oc. 2; Ob. C.
15-16 *Cleome viscosa.*
15 Glandular hair on the leaf.
Oc. 3; Ob. C.
16 T.S. of the leaf.
Oc. 2; Ob. C.

N.B.—To get the original dimensions multiply by 1·7.

in size as the vessels and situated on the upper side of the xylem near the medullary-ray-like strands. Interfascicular wood-prosenchyma is not developed. Wood-parenchyma occurs in groups at the inner margin of the xylem bundles.

The pith is composed of thick-walled cells.

PORTULACEAE.

Portulaca oleracea *L.* (Leaf only).—Clustered crystals in the leaf small and numerous.

Portulaca quadrifida *L.* (Leaf and Axis). Clustered crystals in the mesophyll large and few.

Structure of the Leaf :—The epidermis is composed of polygonal cells with outer and inner walls thickened. The outer walls are arched convexly outwards and are granulated. Stomata are more numerous on the lower surface. The guard-cells are elevated and accompanied by subsidiary cells. The front cavity is on a level with the surface. The mesophyll is composed almost wholly of aqueous tissue, the vascular bundles of the veins being surrounded by palisade parenchyma. Internal secretory organs occur neither in the leaf nor in the axis.

Oxalate of lime occurs in the form of clustered crystals in the aqueous cells of the mesophyll and in the cortex and pith of the axis.

The veins are embedded and are not provided with bundle sheaths; they are surrounded by palisade parenchyma.

The leaf and axis are devoid of hairs.

Structure of the Axis :—The epidermal cells are polygonal with outer and inner walls greatly thickened. The outer walls are convexly arched outwards and are granulated. The stipular rings of silvery long hairs reflect light and protect the axis and leaves against intense light and heat.

The cortex is formed on its outer side of an extensive tissue of thin-walled parenchymatous cells filled with starch granules and on its inner side of chlorophyll containing parenchyma. The cells of the outermost layer of the cortex are collenchymatous. The cortex may occasionally form an aqueous tissue.

The sclerenchymatous pericycle is not developed.

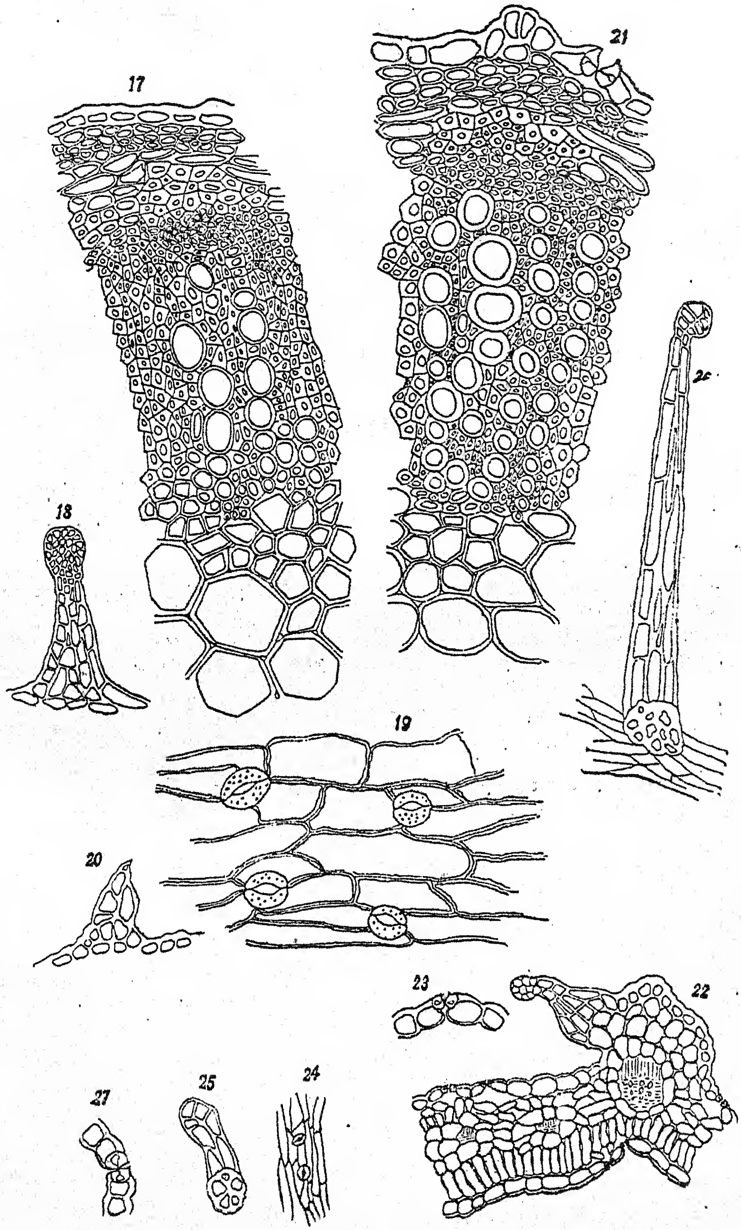
The vascular system is composed of deeply placed vascular bundles separated by thin-walled uniseriate medullary rays. Vessels are small and are arranged in complete rows. The vascular ring is surrounded by green parenchyma. The nearness of the assimilatory tissue to the vascular bundles brings about a quick distribution of the products of assimilation.

(*To be continued.*)

Plate III.

17-18 *Cleome papillosa.*
17 T. S. of the axis.
Oc. 5 ; Ob. C.
18 Hair on the axis.
Oc. 1 ; Ob. C.
19-21 *Cleome brachycarpa.*
19 Epidermis of the axis.
Oc. 3 ; Ob. C.
20 Hair on the axis.
Oc. 1 ; Ob. C.
21 T. S. of the axis.
Oc. 1 ; Ob. 3 mm. Ap.
22-26 *Gynandropsis pentaphylla.*
22 T. S. of the leaf.
Oc. 4 ; Ob. C.
23 Stoma in the T. S. of the leaf.
Oc. 1 ; Ob. 3 mm. Ap.
24 Stoma in surface view on the axis.
Oc. 1 ; Ob. C.
25 Hair on the leaf.
Oc. 3 ; Ob. C.
26 Hair on the axis.
Oc. 3 ; Ob. C.
27 *Capparis decidua.*
Stoma in T. S.
Oc. 1 ; Ob. 3 mm. Ap.

N.B.—To get the original dimensions multiply by 1·8.

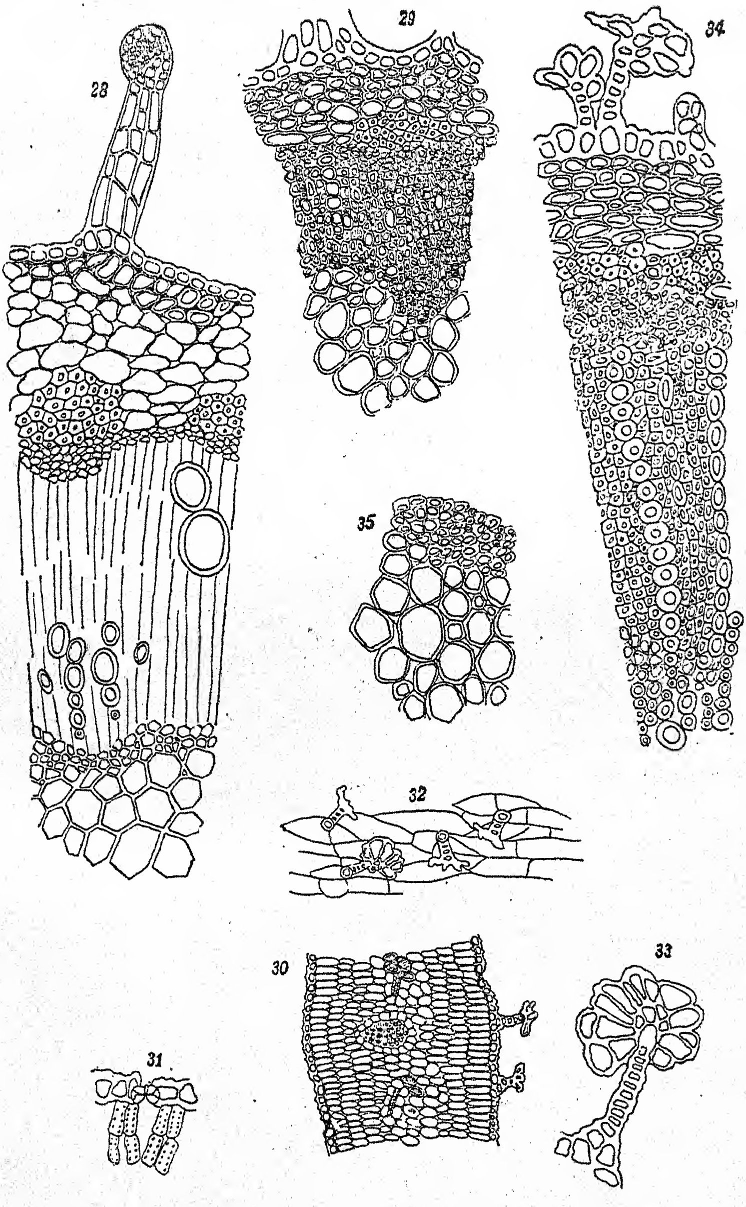


T. S. Sabnis del. PLATE III.

Plate IV.

28 *Cleome viscosa.*
T. S. of the axis.
Oc. 1; Ob. 3 mm. Ap.
29 *Gynandropsis pentaphylla.*
T. S. of the axis.
Oc. 1; Ob. 1/6 Becks.
30-35. *Cadaba indica.*
30. T. S. of the leaf.
Oc. 2; Ob. C.
31 Stoma in the T. S. of the leaf.
Oc. 4; Ob. 3 mm. Ap.
32 Epidermis of the axis.
Oc. 1; Ob. 3 mm. Ap.
33 Hair on the axis.
Oc. 4; Ob. 3 mm. Ap.
34 T. S. of the axis as far as the pith.
Oc. 5; ob. C.
35 T. S. of the axis showing the pith.
Oc. 5: Ob. C.

N.B.—To get the original dimensions multiply by 1·7.



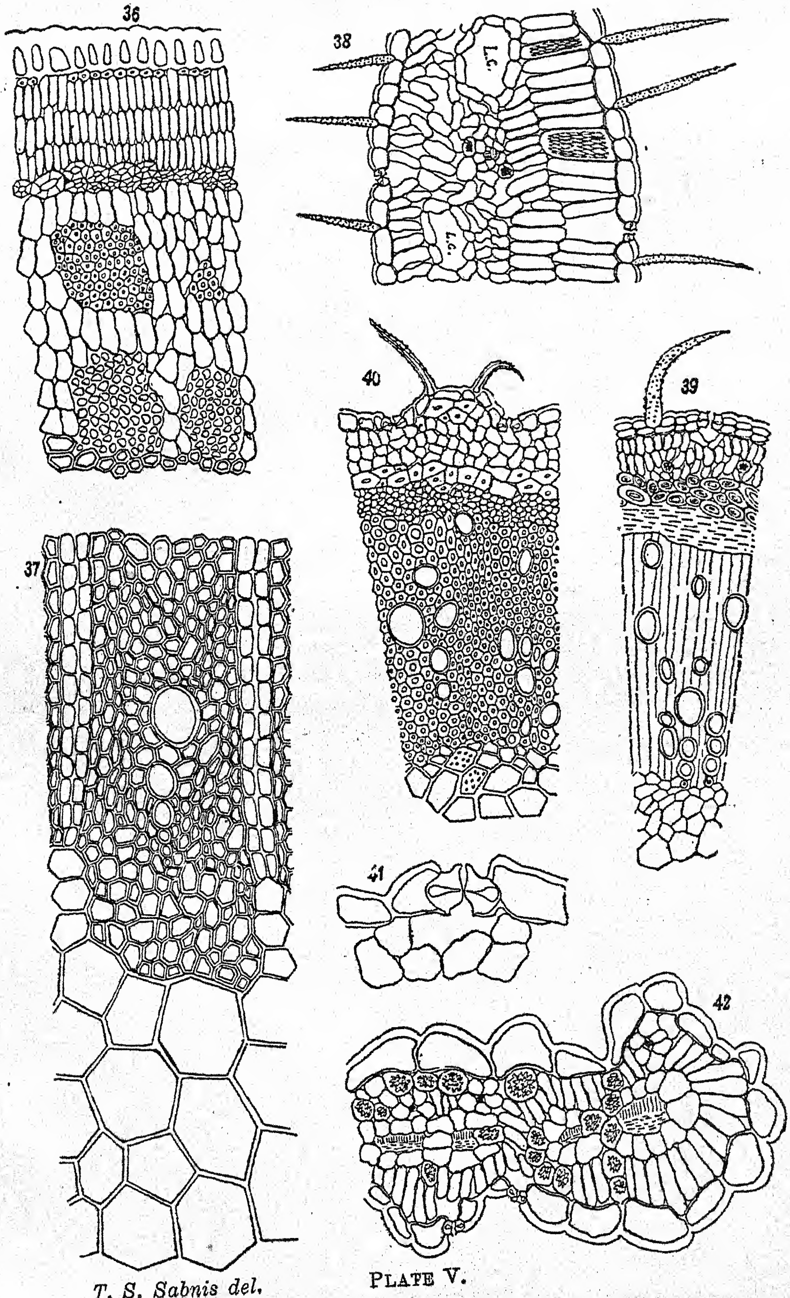
T. S. Sabnis del.

PLATE IV.

Plate V.

36-37 *Capparis decidua.*
36 T. S. of the axis as far as the wood.
Oc. 5; Ob. C.
37 T. S. of the axis showing the wood and pith.
Oc. 5; Ob. C.
38-39 *Polygala erioptera.*
38 T. S. of the leaf.
Oc. 6 Com; Ob. 8 mm. Ap.
39 T. S. of the axis.
Oc. 6 Com.; Ob. 8 mm. Ap.
40-41 *Polygala irregularis.*
40 T. S. of the axis.
Oc. 6 Com.; Ob. 8 mm. Ap.
41 Stoma in the T. S of the axis.
Oc. 6 Com.; Ob. 3 mm. Ap.
42 *Polycarpæa corymbosa.*
T. S. of the leaf.
Oc. 8 Com; Ob. 8 mm. Ap.

N.B.—To get the original dimensions multiply by 1·7.



T. S. Sabnis del.

PLATE V.

Plate VI.

43-44 *Polycarpæa corymbosa.*
43 Stoma in the T. S. of the axis.
Oc. 4 Com.; Ob. 8 mm. Ap.
44 T. S. of the axis.
Oc. 4 Com.; Ob. 8 mm. Ap.

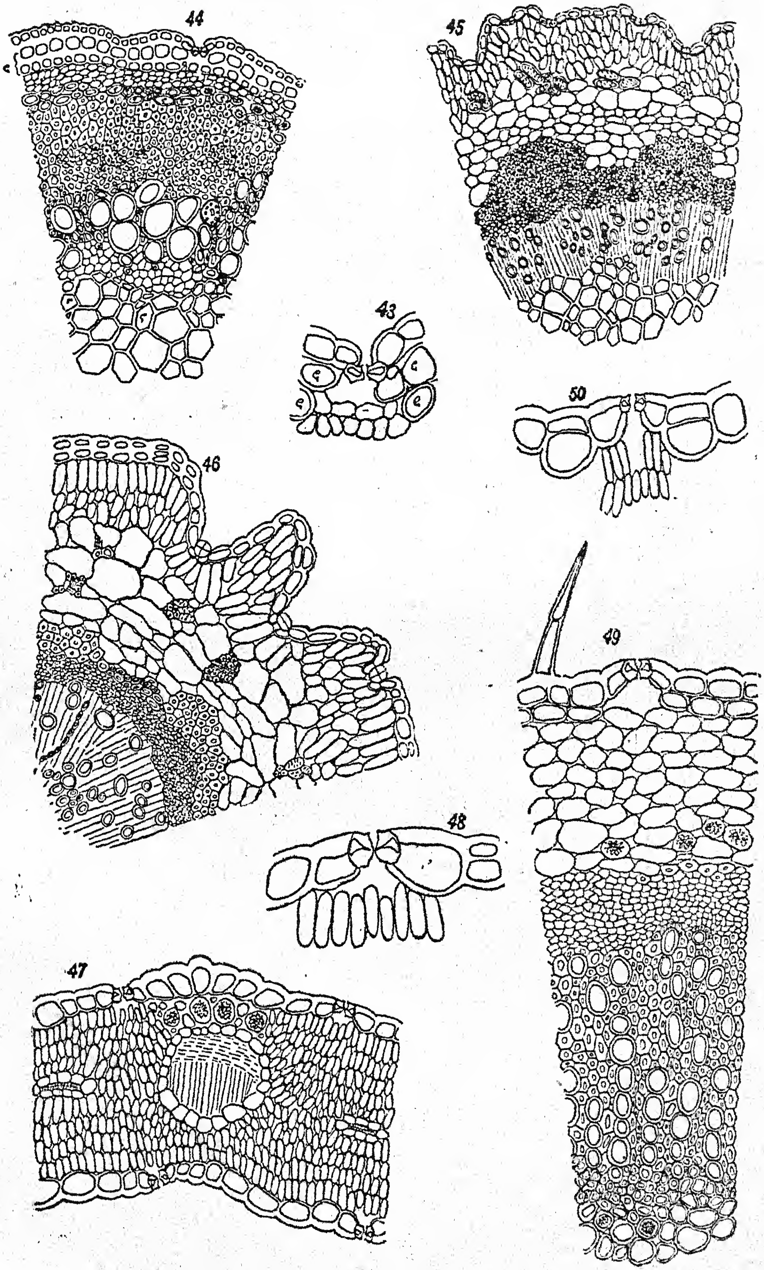
45 *Tamarix dioica.*
T. S. of the axis.
Oc. 4 Com.; Ob. 8 mm. Ap.

46 *Tamarix articulata.*
T. S. of the axis.
Oc. 6 Com.; Ob. 8 mm. Ap.

47-49 *Bergia ammanioides.*
47 T. S. of the leaf.
Oc. 3; Ob. C.
48 Stoma in the T. S. of the leaf.
Oc. 3; Ob. 3 mm. Ap.
49 T. S. of the axis.
Oc. 3; Ob. C.

50 *Bergia odorata.*
Stoma in the T. S. of the leaf.
Oc. 1; Ob. 3 mm. Ap.

N.B.—To get the original dimensions multiply by 1·7.



T. S. Sabnis del. PLATE VI.

CONTRIBUTIONS TOWARDS A FLORA OF BALUCHISTAN.

From materials supplied by Col. J. E. B. Hotson, I.A.R.O.

BY

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St. Xavier's Coll., Bombay.

(*Continued from last issue*)

Resedaceae—(*Cont.*)

RESEDA *L.*

Reseda pruinosa *Del. Fl. Eg. p. 15.* Loc.: Taloi Sunt, 11 miles N. of Pasni, about 50 ft. (no. M 43 B); near Manguli, 157 miles SSW of Kalat, about 2,450 ft. (no. 239). Fl. and fr. in Feb. 1918, Sept. 1917. *Vern. Name*: Mazardum.

Reseda Aucheri *Boiss. Diagn. ser. I, part I, p. 5.* Loc.: Gwambuk, about 60 miles S. by E. of Panjgur, about 2,700 ft. (no. 43C); hills S of Chambar (Kolwa), 26° 9′ N, 64° 42′ E, about 1,800—2,200 ft. (no. 43D). Fl. in April 1918. *Vern. Name*: Mazardum.

OLIGOMERIS *Cambess.*

Oligomeris glaucescens *Cambess. in Jacq. Voy. Bot. 23, t. 5.* Loc.: Kulbar valley, E. of Dagja, 62° 33′ E, 26° 15′ N, about 1,700 ft. (no. 110). Fl. and fr. in March 1918.

Cistaceae.

HELIANTHEMUM *Pers.*

Helianthemum Lippii *Pers. Syn. II, 78* var. **micranthum** *Boiss. Fl. Or. I, 443.* Loc.: Chhuttok, 90 miles S. of Kauat, 4,500 ft. (no. 169, 170). Fl. and fr. in Aug. 1917.

Polygalaceae.

POLYGALA *L.*

Polygala sibirica *L. Sp. Pl. 987.* Loc.: Rari Dan, 170 miles S. by W. of Kalat, 2,300 ft. (no. 283). Fl. and fr. in Sept. 1917. *Vern. Name*: Kaj (Mashna Kaj) (Brah.).

Polygala erioptera *DC. Prodr. I, 326.* Loc.: Wahir, 25 miles S. by W. of Khozdar, about 4,200 ft. (no. 365). Fl. and fr. in Sept. 1917. *Vern. Name*: Choghal (Brah.).

Caryopyllaceae.

DIANTHUS *L.*

Dianthus crinitus *Sm. Act. Soc. Linn. II, 300.* Loc.: Siman river, 15 miles SE of Khozdar, about 3,700 ft. (no. 359). Fl. in Sept. 1917. *Vern. Name*: Aghud? (Brah.).

Dianthus fimbriatus *MB. Taur. Cauc. I, 382.* Loc.: Harboi, 9,000 ft. (no. 43A); Surab, 28° 29′ N, 66° 16′ E about 5,700 ft. (M. 375). Fl. in June 1918, Aug 1917. Uses: Said to be eaten by hares. *Vern. Name*: Aghud (Br.).

SAPONARIA *L.*

Saponaria vaccaria *L. Sp. Pl. 585*, var. grandiflora *Fisch. in DC. Prodr. I, 365.* Loc.: Panjgur, about 3,100 ft. (no. M 144, M 144A). Fl. and fr. in March 1918. *Vern. Name*: Karari (Br.).

SILENE *L.*

Silene conoidea *L. Sp. Pl. 598.* Loc.: Khudabadan, ¼ mile N. of Panjgur, about 3,100 ft. (no. M 178). Fl. in March 1918.

ARENARIA *L.*

Arenaria filiformis *Labill. Dec. IV, 408.* Loc.: Nagak (W. Kolwa), about 87 miles E. by N. of Turbat, about 2,400 ft. (no. M 185A). Fl. and fr. in April 1918. *Vern. Name*: Dandalo (Bal.).

Arenaria sp. (*Near* A. holosteoides). Loc.: Khudabadam, ¼ mile N. of Panjgur, about 3,100 ft. (no. M 183). Fl. in March 1918. *Vern. Name*: Baliko (Bal). Name uncertain.

SPERGULARIA *Pers.*

Spergularia diandra *Boiss. Fl. Or. I, 733.* Loc.: Khudabadan, ¼ mile N. of Panjgur, about 3,100 ft. (no. M 185). Fl. and fr. in. March 1918. *Vern. Name*: Dandalo (Bal.).

Spergularia marginata *Boiss. Fl. Or. I, 733.* Loc.: Near Sitani, 59 miles S. of Kalat, 5,300 ft. (no. 128); Mazarjuh, about 28° 11′ N, 66° 2′ E, about 5,200 ft. (no. M 365). Fl. and fr. in June and Aug. 1918. *Vern. Name*: Makankur (Br.).

Portulacaceae.

PORTULACA *L.*

Portulaca oleracea *L. Sp. Pl. 638.* Loc.: W. side of Burida Pass, 140 miles SSW of Kalat, under 4,250 ft. (no. 250), ; Garrok, 27 miles N. of Ornach, about 3,400 ft. (no. 276A); Shahdadzai, 72 miles S. of Kalat, 5,100 ft. (no. 138); Panchgur (no. M 327); Quetta; Korak (Pelar), 180 miles S. by W. of Kalat, 1,900 ft. (no. 276). Fl. and fr. in May 1918, July 1918, Aug. 1917, Sept, 1917. *Vern. Names*: Pichali, Pechali, (Bal. and Brah.), Mugher (Brah.). Uses: Cooked and eaten as a vegetable.

Tamaricaceae.

TAMARIX *L.*

Tamarix Pallasii *Desv. Ann. Sc. Nat. IV. 349.* Loc.: Siman river, about 15 miles SE of Khozoar, about 3,700 ft. (no. 361). Fl. in Sept. 1917. *Vern. Name*: Siah Gaz (Bal. Br.), Mauna Kiri (Br.).

Tamarix laxa *Willd. Act. Acad. Berol. (1812) 82.* Loc.: Awaran (Kolwa) 26° 24′ N, 65° 12′ E, about 1,750 ft. (M 12B); Dokob, 60 miles W. of Turbat, about 700 ft. (no. M 12); Teghab, 107 miles S. of Kalat, 4,150 ft. (no. 147A); Shahdzai, 72 miles S. of Kalat, 5,100 ft. (no. 147). Fl. and fr. in Aug. 1917, Sept. 1917, Dec 1917.

Vern. Names: Gaz (Bal. Br.), Shingir Gaz (Bal.), Shingir Kiri (Br.). "The names of the tamarisks are rather confused. This variety is called Shingir in Kech and by the Brahuis. It is called Soren (= red) by many Baluchis." (Hotson).

Tamarix articulata *Vahl Symb. II, 48, tab. 32.* Loc.: Awaran (Kolwa), 26° 24′ N. 65° 12′ E, about 1,750 ft. (no. M 14A); Dokop, 60 miles W. of Turbat, about 1,700 ft. (no. M 14); Teghab, 107 miles S. of Kalat, 4150 ft. (no. 117A). Fl. in August 1917, said to flower in spring. *Vern. Names*: Guh Gaz (Bal.), Sakori Gaz (Kiri). Kolwa is the Kech name for this tamarisk. About Mand it is called Guh, the name given in Kech to the Padha Gaz (Hotson). See the next species.

Tamarix stricta *Boiss. Diagn. ser. II, II, 57.* Loc.: Siman river, 15 miles SE of Khozdar, about 3,700 ft. (no. 362); Lukh, 100 miles S. of Kalat, 4,300 ft. (no.177); Dokop, 60 miles W. of Turbat, about 700 ft. (no. M 13, M 13A). Fr. in Aug. 1917, Sept. 1917, Dec. 1917. Vern. Names: Sor Gaz (Bal. Br.), Khisun Kiri (Br.), Sakori Gaz, Sakori Kiri (Bal. Br.), Padha Gaz (Bal.).—This tamarisk is commonly called Padha, but in some parts also Guh Gaz the latter being the Kech name for it. (Hotson).

Tamarix passerinoides *Del. Eg. III. no. 352.* Loc.: Quetta. Fl. in July 1918.

Tamarix longe-pedunculata *Blatt. and Hall. spec. nov.* Frutex (vel arbor ?) glaber, glaucus, dioicus. Folia vaginantia, subhorizontaliter truncata, abrupte deltoideo-mucronata vel cuspidata, in ramis novellis apice patentia, in ceteris adpressa. Racemi racemoso—paniculati, longe pedunculati, elongati, densissimi, ca $5\frac{1}{2}$ cm longi, pedunculo ca. 13 cm longo. Bracteae triangulari-ovatae, acuminatae, floribus sessilibus sub-breviores. Sepala 5, rotundato-obovata, obtusa, duo lateralia carinata, omnia margine scariosa. Petala 5 purpurea ca. duplo calyce longiora, obovato-suborbiculata. Stamina 5, disco 5-glanduloso inserta; antherae apiculatae. Ovarium nullum. Flores femineos non vidimus. This species comes near T. dioica, but differs in the following points: The peduncle is much longer, the petals are obovate suborbicular, not linear-oblong. Loc.: Gajar, 165 miles SSW of Kalat, 3,450 ft. (no. 228). Fl. in Sept. 1917. *Vern. Name*: Gaz (Bal.).

REAUMURIA *L.*

Reaumuria palaestina *Boiss. Diagn. ser. I. I. p. 10* var. **acuminata** *var. nov.* Differt a typo ramis glabris, foliis acutis, calycis laciniis acuminatis apice coriaceis, petalis calyce aliquantulum longioribus. Loc.: Garrok, 27 miles N. of Ornach, about 3,400 ft. (no. 327). Fl. in Sept. 1917.

Reaumuria Stocksii *Boiss. Fl. Or. I, 761.* Loc.: Manguli, 26° 45′ N, 65° 21′ E, about 2,600 ft. (no. M 290; 290A; Zaham, about 42 miles S. of Panjgur, about 2,800 ft. (no. M 205); near Sitani, 59 miles S. of Kalat, 5,300 ft. (136), Panjgur, about 3,100 ft. (no. 141). Korak (Pelar), 180 miles S. by W. of Kalat, 1,900 ft. (no. 274). Fl. and fr. in March and April 1918. *Vern. Name*: Kuhi Drah Chok

(Bal.), Molido (Bal.), Sor (Br.), Simsur (Bal. Br.). Flowers rose-purple or pink.

Reaumuria hypericoides *Willd. Sp. II. 1250.* Loc.: Shireza Patk (Kharan), 27° 46′ N, 65° 37′ E, about 4,900 ft. (no. M 32 C); Kuchkan, about 17 miles SSW of Panjgur, about 2,900 ft. (no. M 139, M 139A); Garrok, 27 miles N. of Ornach, about 3,400 ft. (no. 327); Mitasing, about 17 miles ESE of Panjgur, about 4,000 ft. (no. 27 D). Fl. in March and April 1918. Fr. in March 1918, June 1918, Sept. 1917. *Vern. Names*: Kohalok (Bal.), Sorag, Sorago (Bal. Br.). The flowers are pink.

Reaumuria panjgurica *Blatt. & Hall. spec. nov.* (*Prope* R. Billardieri *J. & S.*) Frutex humilis, ramosissimus a basi, glaucus, glaberrimus ca 25 cm. altus. Cortex radicis necnon ramorum veterum brunneum, exfolians, ramorum juniorum albidum, scabrido-muriculatum. Folia ca. 10 mm longa, 5 mm lata, plana, coriacea, obovato-elliptica vel oblonga, vel linearia-oblonga vel subspathulata, apice generatim rotundato-obtusa, superiora interdum apice subacuta. Flores laxe paniculati, in axillis solitarii ramos breves terminantes. Rami florales interdum foliis parvis linearibus vestiti. Bracteae calyce multo longiores, lineares-spathulatae, subobtusae. Calyx 5-partitus ad medium, subcampanulatus, lobis ovatis-subacutis (non acuminatis), basi subcordatis, coriaceis, anguste scariosis margine. Petala calyce plus duplo longiora, lanceolata-subulata, 10 mm longa, 3 mm lata, basi utrinque squama triangulari-oblonga semiadnata, margine superiore fimbriato. Stamina numerosa in phalanges 5 petalis oppositas basi connata. Capsula coriacea valvis 5 oblongo-acuminatis, multinerviis, 8 mm longis, 2 mm latis. Semina pauca, undique longe-pilosa, pilis seminibus longioribus. Loc.: Panjgur, about 8,500 ft. (no. 321), growing on dry ground. Fl. and fr. in May 1918.

Malvaceae.

MALVA *L.*

Malva rotundifolia *L. Sp. Pl. (1753) 688.* Loc.: Kalat, about 6,350 ft. (no. M 134 B); spring on Harboi, 19 miles ESE of Kalat, 8,800 ft. (no. 78); near Bazdad, 25 miles E. of Chambar (Kolwa), about 1,850 ft. (no. M 134 B); Kochau 122 miles SSW of Kalat 4,175 ft. (no. 78A). Fl. and fr. in March 1918, July 1918. Uses: Ground up, soaked in water, mixed with sweetmeat and drunk. At once relieves retention of urine. Of the fruit an ointment is made for the chest in cases of "dik", a dangerous illness. *Vern. Names*: Utper (Br.), Gwarag Pad (Bal.), Pochako.

ALTHAEA *L.*

Althaea Ludwigii *L. Mantiss. (1767) 98.* Loc.: Mohtaji Kand, about 22 miles SW of Panjgur, about 2,800 ft. (no. M 134, M 138); Harbud, about 55 miles E. of Panjgur about 3,750 ft. (no. M. 311, M 311 A). Fl. and fr. in March and April 1918. *Vern. Names*: Utper (= camel's foot) (Br.), Pochako (Panjguri Bal.) Gwarag Pad (= crow's foot) (Kechi Bal.), Nampacho (Panjguri Bal.), Baharo (Bal.).

SIDA *L.*

Sida grewioides *Guill. & A. Rich. Fl. Seneg. I (1830) 71.* Loc.: Naka Khari (Las Bela), 33 miles from Karachi, about 100 ft. (no. 401). Fl. and fr. in Oct. 1917.

ABUTILON *Gaertn.*

Abutilon indicum *Sw. Hort. Brit. I (1827) 54.* Loc.: Jaur, 34 miles S. by W. of Khozdar, about 4,300 ft. about (no. 372, 372 A). Fl. and fr, in Oct. 1917. Uses: Said to be useless and not eaten by any animals. Also said to be bad for the eyes, and therefore called Baibaro, though how it should get near the eyes I could not understand. (Hotson). *Vern. Name*: Gogharo (Br.).

Abutilon bidentatum *A. Rich. Fl. Abyss. I (1847) 68.* Loc.: Rar Kaur, 165 miles S. by W. of Kalat, about 3,500 ft. (no. 293, 293 B). Fl. and fr. in Sept. 1917. *Vern. Name*: Kapochisk (Br. Bal.).

Abutilon muticum *Sw. Hort. Brit. ed. 2 (1830) 65.* Loc.: Rar Kaur, 165 miles S. by W. of Kalat, about 3,500 ft. (no. 293 A). Fl. in Sept. 1917.

Abutilon fruticosum *Guill. Perr. and A. Rich. Fl. Seneg. I (1830) 70.* Loc.: Hills near Ispikan, about 20 miles NE of Mand, about 1,200-1,500 ft. (no. M 98); Burida Pass, 140 miles SSW of Kalat, up to 4,250 ft. (no. 214). Fl. and fr. in March 1918, August, 1917. *Vern. Name*: Gulkhand (Br.).

PAVONIA *Cav.*

Pavonia arabica *Steud. Nom. ed. 2, II (1841) 279.* Loc.: Naka Kharri (Las Bela), 33 miles from Karachi, about 100 ft. (no. 140). Fl. and fr. in Oct. 1917.

HIBISCUS *L.*

Hibiscus trionum *L. Sp. Pl. (1753) 697.* Loc.: Quetta; Khozdar, 27° 48′ N, 66° 37′ E, about 4,100 ft. (no. 348); Kalat, 7,000 ft. (no. 5); Kalat, about 6,350 ft. (no. M 398); Surab, 43 miles S. of Kalat, 5,750 ft. (no. 107). Fl. in July 1918, Aug. and Sept. 1917.—Fr. in Aug. 1917, Sept. 1917. Uses. The leaves when very small are cut off and boiled, and after some preparation eaten with bread. Those leaves are called Garbust. *Vern. Names*: Pihu Pulli (Br.). Lasura (Br.).

Hibiscus micranthus *L. f. Suppl. (1781) 308.* Loc.: Near Manguli, 157 miles SSW of Kalat, about 2,450 ft. (no. 238); near Korak (Pelar), 180 miles S. by W. of Kalat, 1,900 ft. (280); hills S. of Chambar (Kolwa), 26° 9′ N, 64° 42′ E, about 2,150 ft. (no. M 25 B); hills near Ispikan, about 20 miles NE of Mand, about, 1,200-1,500 ft. Fl. and fr. in March and April 1918. *Vern. Name*: Zwangir.

Hibiscus pungens *Roxb. Hort. Beng. 50.* Loc.: Near Ornach, about 3,050 ft. (no. 321, 321 A). Fl. and fr. in Sept. 1917. *Vern. Name*: Mirani, Danku.

Tiliaceae.

GREWIA *L.*

Grewia tenax *Fiori Bosc. Piant. legn. Eritrea (1909) 246*—(G. populifolia *Vahl*). Loc.: Hushtar Rahi, 160 miles S. of Kalat, about

3,700 ft. (no. 280 A, B,); near Kanoji, about 47 miles N. of Las Bela on the road to Wad, about 3,200 ft. (no. 280 C); near Bazdad, 25 miles E. of Chambar (Kolwa), about 1,850 ft. (no. 36 E), Karochi darkaf, 60 miles NE of Pasni, about 1,350 ft. (no. M 36); hills near Ispikan, 20 miles NE of Mand, 1,200 to 1,500 ft. (no. M 36 A); near Chambar (no. M 36 B). Fl. in March 1918, Sept. 1917.—Fr. in Feb. 1918, Sept. 1917. Oct. 1917. Uses: The berries make a medicine for colds. Used as medicine for all sorts of diseases and very highly esteemed. (Hotson.) *Vern. Names*: Gwangir (Br. Bal.), Putrunk (Mandi Bal.). The Baluchis call this Buzi Putrunk (= goat's putrunk), to distinguish it from the next.

Grewia villosa *Willd. in Ges. Naturf. Fr. Neue Schr. IV (1803) 205.* Loc.: Hills near Ispikan, about 20 miles NE of Mand, about 1,200—1,500 ft. (no. M 84); hills S. of Chambar (Kolwa), 26° 9′ N. 64° 42′ E., about 2,000—2,200 ft. (no. M 262). *Vern. Name*: This is called Pachini (ibex) putrunk to distinguish it from the Buzi (or she-ibex) putrunk.

CORCHORS *L.*

Corchorus antichorus *Raeusch Nom. ed. 3 (1797) 158.* Loc.: Pirandar, 205 miles SSW of Kalat, about 1,900 ft. (no. 260); Zahren Kahur, 16 miles N. of Pasni, about 200 ft. (no. M 41). Fl. in Sept. 1917.—Fr. in Feb. 1918, Sept. 1917. Uses: A cooling drink is made from the leaves. *Vern. Name*: Munderi (Bal. Sindhi).

Zygophyllaceae.

TRIBULUS *L.*

Tribulus terrestris *L. Sp. Pl. 554.* Loc.: Shahdazai, 72 miles S. of Kalat, 5,700 ft. (no. 142); Garrok, 27 miles N. of Ornach, about 3,400 ft. (no. 325); near Manguli, 197 miles SSW of Kalat, about 2,450 ft. (no. 244). Fl. and fr. in Aug. and Sept. 1917. *Vern. Name*: Gurgunduk (Br.), Surinchk.

Tribulus alatus *Del. Eg. Ill. no. 438.* Loc.: Rek Chah, 11 miles E. of Chambar (Kolwa), about 1,800 ft. (no. M 269). Fl. and fr. in April 1918. *Vern. Name*: Kahurkah (Bal.).

FAGONIA *L.*

Fagonia Bruguieri *DC. Prodr. I, 704.* Loc.: Quetta; Zahren Kahur, 16 miles N. of Pasni, about 200 feet (no. M 8B). Fl. and fr. July 1918. *Vern. Name*: Karkawag (Bal.).

Fagonia myriacantha *Boiss. Diagn. ser. I, VIII, 123.* Loc.: Baran Lak, 28 miles S. of Wad, about 3,900 ft. (no. 237A). Fl. and fr. Oct. 1917. *Vern. Name*: Karkawag (Br. Bal.). Note: Flowers rather a deeper mauve than usual. They vary from pale mauve to practically white.

Fagonia Olivieri *DC. Prodr. I, 704.* Loc.: Near Manguli, 197 miles SSW of Kalat, about 2,450 ft. (no. 237); Dokop, 60 miles W. of Turbat, about 700 ft. (no. M 8, M 8 A). Fl. in Sept. 1917, Dec. 1917.—Fr. in Sept. 1917. *Vern. Names*: Karkavag (Br. Bal.)

Fagonia spinosissima *Blatt. & Hall. spec. nov.* Frutex a basi ramosissimus, caulibus procumbentibus, veteribus teretibus albidis,

novellis viridibus-glaucis, minutissime et breviter glandulosis, subtetragonis sulcatis. Internodia elongata, 10-20 mm longa. Spinae folia excedentes, 25 mm attingentes, patentes, acerosae, elegantes. Folia elliptica vel elliptico-oblonga, unifoliolata, maxima 15 mm longa et 6 mm lata, spinuloso-mucronata, glanduloso-puberula, nervis obscuris, margine aliquantulum incurvata, petiolata, petiolo 4 mm attingente. Sepala lanceolata vel ovato-lanceolata, acuminata, glanduloso-puberula. Petala non vidimus. Pedunculus recurvus variabilis, generatim capsulae aequilongus, glanduloso-puberulus. Capsula duplo latior quam longa, profunde 5-loba, depressa, acuta, velutina et glanduloso-puberula. Stylus persistens, capsulae aequilongus vel brevior. Semina ovoidea, valde compressa, foveolata-punctata. (Sub microscopio glandulae minutissimae nitentes unamquamque foveolam circumdantes conspici possunt). Differt a Fagonia Olivieri glandulis non sessilibus, spinis folia multum superantibus, forma foliorum et sepalorum, foliis longe-petiolatis. Loc.: Panjguri (no. M 8 E). Fr. in May 1918. *Vern. Name*: Karkawag (Bal.).

Fagonia arabica *L. Sp. Pl. 553.* Loc.: Manter Juzhaf, about 40 miles S. of Panjgur, about 3,200 ft. (no. M 203). Fr. in April 1918. Uses: The roots and thicker parts of the stems of this plant are said to be good for coughs. They are either chewed raw, or boiled in water and the water drunk. I chewed a piece of root and found it strongly astringent, and the taste very lasting. It is said that large quantities of the roots are exported from this neighbourhood to Sind and other countries. (Hotson.) *Vern. Name*: Shurdo, or Shordu (Bal.).

Fagonia sp. *Prope* F. thebaicam *Boiss.* Loc.: Harboi, 18 miles ESE of Kalat, 9,000 ft. (no. 73); under Harboi, 16 miles ESE of Kalat, 8,400 ft. (no. 45). Grows in thick clusters. *Vern. Name*: Chunak gird pith.

ZYGOPHYLLUM *L.*

Zygophyllum eurypterum *Boiss. & Buhse Aufz. 49.* Loc.: Kuchkan, about 17 miles WSW of Panjgur, about 2,900 ft. (no. M 135); Kalgali Kaur, N. of Zayaki Jangal, about 4,800 ft., one of the commonest plants (no. M 135 C); Shahdadzai, 72 miles S. of Kalat, 5,100 ft., exceedingly common all over this country and Makran. Grows low and is so constantly grazed down by camels and other animals that it is very rare to find any leaves on it (no. 150). Fr. in March 1918. *Vern. Name*: Kirech, Alonj.

Zygophyllum trialatum *Blatt. & Hall. spec. nov.* Frutex, ramis albidis sulcatis, ad nodos incrassatis. Folia obovato-obtusa, interdum mucrone minutissimo, in petiolum attenuata, petiolo laminae tertiam partem attingente, 30 mm longa, 15 mm lata, juniora pubescentia, vetera glabra. Stipulae breviter triangulares, longe-cuspidatae. Flores axillares, solitarii. Pedunculi calyce 4-plo longiores, aliquantulum pubescentes, fructificantes ad apicem incrassati. Sepala 4, 5 mm longa, 2½ mm lata, oblonga, margine scariosa, apice obtusa vel retusa, in parte apicali tantum pubescentia. Squamae 4, oblonga, fimbriatae in parte dimidia superiore, ovario aequilongae. Petala sepalis duplo longiora flava, late elliptico-oblonga, obtusa, glabra,

Stamina 8, exserta. Stylus ovario duplo longior. Capsula trialata globosa, depressa, basi et apice retusa. Differt a Zygophyllo euryptero pedunculis longis, stipulis longe-cuspidatis, capsula trialata. Loc.: Quetta. Fl. and fr. in July 1918.

Zygophyllum simplex *L. Mant. 68.* Loc.: Las Bela, about 700 ft. (no. 398). Fl. and fr. in Oct. 1917. *Vern. Name*: Fesul (Sindhi of Bela).

Zygophyllum fabago *L. Sp. Pl. 551.* Loc.: Quetta; Kulbar valley above Dagja, 62° 32′ E. 26° 15′ N. (no. M. 31 A.). Fl. in July 1918. *Vern. Name*: Shurdu (Bal.).

Zygophyllum coccineum *L. Sp. Pl. 551.* Loc.: Junction of Raghai and Sichk rivers (Kharan), about 3,600 ft. (no. M 31 C); Karochi Darkaf, about 60 miles N. by E. of Pasni, about 1,400 ft. (no. M. 31 A.); Turbat, about 600 ft. (no. M 3); Kaurdat 10 miles N. of Rekin, about 1,900 ft. (no. M. 31 B.); NE of Hoshap, about 60 miles ENE of Turbat, about 2,000 ft. (no. M 31); near Manguli, 197 miles SSW of Kalat (no. 234). Fl. in Feb. and April 1918. *Vern. Names*: Shurdu (Bal. Br.), Sohro (Bal). Note: The leaves seem to vary a good deal. We note the following forms: (a) All leaves unifoliolate, leaflets cylindrical, one only clavate, shorter than the petiole, green; (b) All leaves unifoliolate, cylindrical, about as long as the petiole, reddish; (c) Leaves, 1-2-foliolate. Leaflets shorter than petiole, generally clavate; (d) Leaflets 1 or 2, of variable length, sub-cylindrical.

SEETZENIA *R. Br.*

Seetzenia orientalis *Dcne. Fl. Sin. 56, tab. 7.* Loc.: Near Bazdad, 25 miles E. of Chambar (Kolwa), about 1,850 ft. (no. M 95 C). Fl. in April 1918. *Vern. Name*: Cheink (Bal.).

PEGANUM *L.*

Peganum harmala *L. Sp. Pl. 638.* Loc.: Kalat, 7,000 ft. (no. 2); Chahdadzai, 72 miles S. of Kalat, 5,100 ft. (no. 2 C); Quetta; Pirandar, 205 miles SSW of Kalat, about 1,900 ft.; Sarchib, about 62° 40′ E., 26° 16 N (no. M 119); Nag (W. Kolwa) about 83 miles E. by N. of Turbat, about 2,300 ft. (no. M 119 A); Zayaki Jangal, 27° 54′ N, 65° 51′ E, about 4,600 ft. (no. M 119 B); Sitani, 59 miles S. of Kalat, 5,300 ft. (no. 2 B). Fl. in April and July 1918, Sept. 1917.—Fr. in June 1918, Aug. 1917. Uses: The seeds are burnt on charcoal or coal, and their scent, which is pleasant, inhaled by people who are sick in any way. *Vern. Names*: Kisankur (Bal. Br.), Aspantan, Gandako (Bal.). The seeds are called "harmul".

Geraniaceae.

MONSONIA *L.*

Monsonia heliotropioides *Boiss. Fl. Or. I (1867) 897.* Loc.: Hushtar Rahi, 160 miles S. of Kalat, about 3,700 ft. (no. 303). Fl. in Sept. 1917. *Vern. Name*: Gudbaher (Br. Bal.).

ERODIUM *L'Herit.*

Erodium laciniatum *Cav. Diss. 228, tab. 113, fig. 3.* Loc.: Quetta. Fr. in July 1918.

(*To be continued.*)

CURRENT LITERATURE.

New Indian Species, etc.

Bonnaya bracteoides *Blatt. and Hall, Spec. Nov., Journ. Bomb. Nat. hist. Soc. XXV (1918) 416.*

Bonnaya estaminodiosa *Blatt. and Hall, Spec. Nov., l. c. 416.*

Bonnaya quinqueloba *Blatt. and Hall, Spec. Nov., l. c. 417.*

Bonnaya micrantha *Blatt. and Hall, Spec. Nov., l. c. 417.*

Bonnaya veronicaefolia *Spreng.*, **Bonnaya grandiflora** *Spreng.*, and **Bonnaya verbenaefolia** *Spreng.* should be considered as distinct species according to Blatter and Hallberg, *l.c. 418-19.*

Ilysanthes hyssopioides *Benth*, and **Ilysanthes parviflora** *Benth.* According to Blatter and Hallberg (l. c. 419—20) their synonymy should be corrected as follows :—

Ilysanthes hyssopioides *Benth. in DC. Prodr. X, 419*—Gratiola hyssopioides *Benth Scroph. Ind. 34.*

Ilysanthes parviflora *Benth, in DC. Prodr. X, 417.*—Gratiola parviflora *Roxb. Cor. Pl. III, 3, t. 203; Fl, Ind. I, 104*,—Bonnaya hyssopioides *Wight Ic. t. 857.*—Bonnaya parviflora *Benth, Scroph. Ind. 34.*

Mazus McCannii *Blatt and Hall. Spec. Nov.*, Journ. Bomb. Nat. Hist. Soc. *XXV (1918) 423.*

Lindenbergia urticaefolia *Lehm.* to include L. polyantha *Royle*, according to Blatter and Hallberg, *l.c, 424.*

Rotala pentandra *Blatt. and Hall. Nov. Comb., l.c. 707.*

Rotala Fysonii *Blatt. and Hall, Spec. Nov.*

Rotala stipulata *Blatt. and Hall. Spec. Nov., l.c. 710.*

Rotala indica *Blatt. and Hall. Nov., Comb., l.c. 711.*

Rotala rotundifolia *Blatt. and Hall. Nov. Comb., l.c. 718.*

Ammannia desertorum *Blatt. and Hall. Spec. Nov., l.c. XXVI (1918) 213.*

Farsetia macrantha *Blatt. and Hall. Spec. Nov., l.c. 220.*

Melhania magnifolia *Blatt. and Hall. Spec. Nov., l.c. 228*

Zizyphus truncata *Blatt. and Hall. Spec. Nov., l.c. 234.*

Psoralea odorata *Blatt. and Hall. Spec. Nov., l.c, 238.*

Tephresia multiflora *Blatt. and Hall. Spec. Nov., l.c. 239.*

Tephrosia petrosa *Blatt. and Hall. Spec. Nov., l.c. 239.*

Rhynchosia rhombifolia *Blatt. and Hall. Spec. Nov., l.c. 242.*

Rhynchosia arenaria *Blatt. and Hall. Spec. Nov., l.c. 243.*

Euphorbia laeta *Heyne* and **E. oreophila** *Mig.* have been restituted by L. J. Sedgwick to their former rank of species in place of E. Rothiana *Spreng., l.c. 599.*

E. B.

The Flora of Persian Baluchistan and Makran.

Blatter, E, and Hallberg, F.: *Journal of the Bombay Natural History Society XXV 4.*

The Rev. E. Blatter, S.J., and Prof. F. Hallberg publish a list of the species collected in this area by Capt. I. G. B. Hotson, I.A.R.O. No analysis of the flora is given, but the list shows many genera of our drier districts, represented sometimes by the same species as in S. India, along with genera

of cooler climates. Among the latter are species of *Ranunculus*, *Fumaria*, *Lathyrus*, *Draba*, *Tamarix*, *Astragalus*, *Vicia*, *Prunus*, *Bupleurum*, *Carduus*, *Olea*, *Antirrhinum*, *Linaria*, *Plantago*, *Euphorbia*, *Salix*, *Populus*, and *Asphodelus*; many of them by the same species as occur in Europe. Among genera and species common in South India are *Cleome*, *Capparis*, including (*C. aphylla* Roth which occurs in Tinnevelly), *Tribulus*, *Citrus medica* (orange), *Gymno, sporia montana* Benth., *Zizyphus jujuba* Lam., *Dodonœa viscosa* L., *Desmodium*, *Terminalia Catappa* L., *Eugenia jambolana* Lam., *Launœa*, *Tylophora*, *Cordia myxa* L., *Heliotropium*, *Trichodesma*, *Solanum nigrum* L., *Sesamum indicum* D.C., *Ocimum basilicum* L., *Ærua lanata* Juss., *Aristida*, and several others. Many of the common species are no doubt cultivated, for the sake of their edible fruits or their use for pot-herbs; but apart from them it is clear that, though the species are different, there is a good deal of affinity in the genera, between the Persian Baluchistan and the drier parts of the Carnatic. The temperate genera and species, it will be noticed, are mostly herbs and without doubt belong to the cool winter months.

P. F. F.

Flora of Northern Gujarat.

W. T. Saxton, M.A., F.L.S., I.E.S., I.A.R.O., and **L. J Sedgwick**, B.A., F.L.S., I.C.S., Plants of Northern Guzarat.—*Records of the Botanical Survey of India, Vol. VI, No. 7.*

Though published in 1918, this monograph was written in 1914-15. As the authors explain, it deals with only a small fraction of Northern Gujarat, namely, the immediate neighbourhood of Ahmedabad, and the taluks of Prantij and Modasa, which lie to the north-east of that city. These taluks touch the fringe of the great Malwa forest region. Kharagoda on the Rann of Cutch has been included on the strength of one visit, and this has resulted in the inclusion of some of the halophytes of the Rann, with the inevitable omission of others, and excludes the possibility of a full discussion of the flora of that interesting region.

The work is divided into three parts, viz., Part I—Descriptive and Analytical, Part II—Œcology, and Part III—Flora. As described in the first part the area worked includes the pure sand tracts round Ahmedabad, some black soil tracts in Modasa, and the stony hills near Modasa where the Malwa forests begin. The main interest of this part of the work is that it brings out how the Perso-Arabian flora and the Indo-Malayan flora meet in Gujarat. On the whole the character of the flora of the sand tracts is essentially Perso-Arabian. The Perso-Arabian plants mentioned on page 216 are, as the floral part shows, denizens of the sand region; while the Indo-Malayan plants listed on the same page are similarly seen to be mainly denizens of the Malwa forest system. The line dividing the two great floras is, therefore, fairly definite, and could be ultimately plotted on a floral map of Asia. Apart from the presence of Perso-Arabian plants the total absence of many of the important Indo-Malayan families and genera is significant. For instance, there is not a single Orchid, Aroid, Amaryllid or Ginger, nor any species of Strobilanthes, Dalbergia, Hedyotis, Anotis, Flemingia, Smithia, Impatiens, Arundinella and a host of other typically Indo-Malayan genera. The flora is essentially a xerophytic one, with the addition of an important swamp flora typical of Indian marshes and tanks. In fact this swamp-flora and a handful

of trees confined to the Malwa region are the only links with Indo-Malaya. A noteworthy feature is the abundance of Gramineæ and Cyperaceæ, which together total 148 out of the 614 species.

This work adds twenty-two truly wild and three alien species to the Bombay flora, and establishes as genuine indigenous species ten which are excluded in Cooke's work. Thus thirty-five species may be said to have been added to the flora. In addition to this our knowledge of distribution of other species within the Presidency has been materially advanced.

Part II deals with the œcology of the district. The authors have accepted Warming's analysis of the world's flora as a basis upon which to work, and have considered that the great bulk of the area discussed belongs to his class 10, Psilophytes. In Warming's use of the word this term is equivalent to savannah. The woodland savannah consists of the Teak *Tectona grandis*. Bael *Aegle marmelos*, *Morinda citrifolia*, *Odina wodier* and other trees familiar to botanists on the other, eastern, side of India, along with shrubs like *Helicteres isora*, *Carissa carundas*, *Holarrhena antidysenterica* and *Nyctanthes arbor-tristis*. The 'thorn-savannah' in the same way consists largely of *Zizyphus œnoplia*, *Z. jujuba*, *Gymnosporia montana*, *Cassia auriculata*, *Capparis sepiaria* and others, all common enough on the dry hills of S. India.

As regards other associations, the flora of open sheets of water such as 'tanks,' and the slow moving rivers (Hydrophytes), and also that of their banks (Helophytes) are both very similar to those of similar situations in the Carnatic—*Nymphœa lotus*, *Hydrilla verticillata*, *Trapa bispinosa*, *Jussiæa repens* and *Nitella sp.* in the water: *Herpestis Monniera*, *Lippia nodiflora* and *Marsilia quadrifoliata* on their banks, to mention only a few. The dried mud such as one finds in dried tanks also bears very similar vegetation to that of Madras—the Babul *Acacia arabica* being abundant, and prostrate herbs like *Coldenia procumbens*, *Chrozophora plicata*, *Mollugo hirta* and *Polygonum plebejum*. The Mesophytic flora is, on account of the general dryness of the country, distinctly poor; and only two examples are noted by the authors where the ground was kept permanently moist, one by a tank, the other by a spring. Nearly all the plants given are such as occur in similar places in South India.

The authors have added some notes on the associations of cultivated lands, with a list of the common weeds and hedge-plants. In North Gujarat the hedge is a much more important feature than in other parts of India and harbours a definite and not uninteresting flora. Their list comprises the trees and other woody plants, the climbers, and the small herbs: and they distinguish them according to the degree of commonness or rarity, and the climbers according also to their habit of the roots or lower portions.

This œcological part is, perhaps, the first instance of such work in India, and the example will, it is to be hoped, be followed in other parts of this country.

Histology.

Beer, R., and **Arber, Agnes.** On the occurrence of Multinucleate Cells in Vegetative Tissues. *Proc. Roy. Soc. B. 91; B. 635 p. 1. (Aug. 1919)*

That multinucleate cells occur occasionally in plants has been known ever since the days of Naegeli, but chiefly in connection with specialised

tissues or cells, as embyro sacs, tapetal cells, pollen tubes, etc. In 1915 Miss Pramkherd drew attention to the frequent occurrence of such cells in different tissues of young organs of widely different but by no means specialised character. Among ferns they were found in the petiole and sporangiophore; among phanerogams in petiole, hypocotyl, coleoptile, stem, inflorescence axis, plumule bud and peduncle. They tend to occur in regions of activity and rapid elongation, and are due, she supposed, chiefly to amitotic division, and being probably followed by wall-formation, might contribute to the rapid formation of the tissue. Rudolf Beer and Agnes Arber in the paper now under notice, record the occurrence of binucleate and multinucleate cells in vegetative tissues of 177 species representing 60 families, most frequently in the stem but also in roots, and always characteristic of young actively growing tissues. In opposition to the majority of observers they consider that the division of the nucleus has always been a mitotic one, no single instance of direct division having been observed. A peculiarity in the development of the binucleate condition is the formation of what the authors propose to call the *Phragmosphere.* After the spindle plate has made its appearance it is apparently resorbed, and the whole phragmoplast with its associated cytoplasm becomes transformed into a hollow sphere which encloses the two nuclei and ultimately becomes co-extensive with the cytoplasm lining the cell-wall.

The fate of the nuclei varies: in some cases they persist, even, as in the cortex of *Rosa*, for two years. In some they soon degenerate, but there is no evidence of fusion.

From the frequency of the occurrence of bi-nucleate and multinucleate cells in growing tissues the authors regard them as a normal feature, a definite phase in the growth of the higher plants.

This phase usually succeeds the meristematic stage and preceeds the period of maximum growth and may therefore be considered as due to a loss by the cytoplasm of the power to divide, while the nucleus is still capable of doing so. The authors are inclined to think that the diffusion into the cytoplasm of the nuclear material both at each division (because of the solution of the nuclear-membrane) and on the disintegration of the nuclei, may contribute to the cytoplasm and affect its activities.

P. F. F.

Hepaticae.

Campbell D. H. Studies on some East Indian Hepaticae. *Annals of Botany Vol. XXII. No. CXXVII. July 1918.*

The writer describes the structure and development of some species of *Dumortiera* and gives the description of a new monœcious species of the genus from Borneo characterised by the formation of several (5-6) sessile successive male and female receptacles on a series of terminal adventitious shoots. The stucture of *Wiesnerella denudata* (Mitten) St, is also described. The author concludes that *D. velutina* shows the least reduction, for not only are the outlines of the air-chambers quite evident, but the characteristic assimilative tissue is present in the form of very numerous superficial papillate cells. In *D. trichocephalla*, which is more strongly hygrophilous in habit, the reduction of the air-chambers is much more complete, and in a third species, from Hawaii, probably *D. hirsuta*, the suppression is complete.

Wiesnerella is said to be closely related to *Dumortiera* on the one hand, while on the other it is connected with the typical *Marchantiaceae.* About the only evidence of reduction in *Wiesnerella* is the character of the stomata especially on the receptacles. According to the writer it connects forms of the type *Marchantia* with the reduced *Dumortiera.* In the reviewer's opinion we might even go further and say that on the *Marchantia* side it is related to *Fegatella conica* which occurs in similar moist places—in fact the two were collected by him from the same locality growing side by side on the road from Dalhousie to Khajiar in the western Himalayas.

Graham, Margaret. Centrosomes in Fertilisation stages of *Preissia commutata* (Scop) Nees. *Annals of Botany Vol. XXII. No. CXXVII. July 1918.*

The writer has studied the process of fertilisation in *Preissia commutata* at a stage when the uncleus of the antherozoid lies near the centre of the egg. The conclusion is that centrosomes as definite granular bodies are present in the fertilised egg at the time when the nuclei are paired, just as they are present in the divisions proceeding spermatogenesis and as blepharoplasts during metamorphosis.

Cribbs, J. E., A Columella in Marchantia polymorpha. *Botanical Gazette. Vol. 65 No. 1 Jan. 1918.*

Cases are described and figured in which elaters were found aggregated in the centre of the capsule forming a sort of columella instead of being scattered throughout the cavity which is the usual mode of their occurrence. Some of the sporogenous cells intermingled with the elaters near the centre are disorganised in the course of development. A columella of this type is said to strongly suggest the elaterophore of *Pellia.* The cap of sterile cells at the tip of the capsule occasionally consisting of three or four layers of cells is also described. Both these features are very interesting as they bring the structure of the capsule of *Marchantia* into line with the other liverworts in which these characters are met with.

Haupt, A. W., A Morphological Study of Pallavicinia Lyellii. *Botanical Gazette. Vol. LXVI No. 6 December 1918.*

The structure and development of the thallus, sex organ and the sporogonium is described. The branching of the thallus which consists of a single prostrate portion is both apical and adventitious. It is dioecious. The antheridia occur in two rows on each side of the midrib, and each is protected from behind by an involucral upgrowth. The archegonia are in dorsal groups sorrounded by an involucre and a perianth. The lower half of the fertilised egg becomes a haustorial organ and contributes nothing to the development of the foot, seta or capsule. The calyptra is 4 or 5 cells in thickness. The differentiation of the spores and elaters follows the mothod of *Symphyogyna.* A sterile cap is present at the apex of the capsule and remains intact in dehiscence which takes place by means of four longitudinal slits.

S. R. KASHYAP.

Printed and Published for the Proprietor by W. L. KING at the Methodist Publishing House, Mount Road, Madras.

THE

Journal of Indian Botany.

VOL. I. DECEMBER, 1919. No. 4.

THE PHYSIOLOGICAL ANATOMY OF THE PLANTS OF THE INDIAN DESERT

BY

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(Continued from last issue.)

Portulaca quadrifida, *L.*—(*Cont.*). The pith is composed of thin-walled cells filled with starch granules.

The two features, viz: the peripheral position of the aqueous tissue and the central position of the assimilatory tissue near the vascular bundles are quite significant. The acqueous tissue from its peripheral position is able to absorb moisture easily and carry on its function without being disturbed by any other tissue situated outside. It further protects the assimilatory tissue from the injurious effects of intense light and heat.

Were the assimilatory tissue peripheral, the products of assimilation would have to travel a long distance before they could reach the vascular bundles; thus the distribution of the products of assimilation would be greatly retarded. Therefore either the assimilatory tissue should be centrally placed near the vascular tissue or the aqueous tissue should be reduced, so that the distribution of the assimilatory products may go on rapidly.

It is possible that the assimilatory tissue enclosed by an extensive aqueous tissue may not get enough light, but this cannot be helped. As the development of an aqueous tissue is necessary for succulent plants, the central position for the assimilatory tissue is the only position, so that both the tissues can carry on their work without being interfered with by the other.

TAMARISCINEAE.

Tamarix dioica *Roxb.*—Pl. VI, fig. 45. Epidermal cells with inner walls a little more thickened than outer walls. Pits not deep. Cortical parenchyma of small cells. Sclerenchymatous pericycle more or less forming a loose ring of stone-cells with interposing cells thickened and radially striated. Wood forming a composite hollow cylinder. Soft bast forming groups. Medullary rays 2-6 seriate. Pith composed of thick-walled cells.

Tamarix orientalis *Forsk.*—Fig. 46. Epidermal cells with outer and inner walls thin. Pits quite deep. Cortical parenchyma formed of large thin-walled cells. Sclerenchymatous pericycle more or less isobilateral. Wood forming a composite central cylinder without a central pith tissue. Soft bast forming a continuous ring. Medullary rays uniseriate and few.

Structure of the Axis :—The epidermis consists of thin-walled horizontally tabular cells. The front cavity is depressed and closed above and below by thin walls, fig. 45. The guard-cells are in the plane of or in a plane lower than that of the surrounding cells.

Clothing hairs are not found on the axis of either of the species. External glands, figs. 45, 46, are placed in pits; they form spherical structures divided by horizontal and vertical three-wall into four thin-walled cells, and are accompanied on their inner side by two depressed epidermal cells which form the subsidiary cells of the glands. The glands do not project above the surface; they secrete hygroscopic salts which fill the pits and absorb moisture from the air outside.

The primary cortex is characterised on its outer side by an assimilatory tissue of palisade cells and on its inner side by cortical colourless parenchyma. There are numerous water-storing tracheids in the cortical parenchyma with pitted or scalariform thickenings, the larger ones being accompanied by a few stone-cells. Cortical parenchyma forms an aqueous tissue and in *T. orientalis* is composed of large thin-walled cells.

The pericycle is composed of large groups of stone-cells. The stone-cell groups in *T. dioica* are closely placed all round the soft bast and the cells interposed between them are characterised by sclerosis and by radical striation of the wall. In *T. orientalis* stone-cell groups are placed on two opposite sides in the form of arcs and the cells interposed between them are thin-walled and parenchymatous. The sides possessing the stone-cell groups may perhaps represent the plane of the axis most affected by the wind; and the stone-cell groups may have been developed in that plane to protect the axis against violent shaking by the wind.

The structure of the wood differs in the two species. In *T. orientalis* (fig. 46) the wood forms a composite solid central cylinder and is composed of numerous small vessels embedded in interfascicular wood prosenchyma. In *T. dioica* (fig. 45) the wood forms a composite hollow central cylinder enclosing a small pith tissue and consists of xylem bundles connected together by interfascicular wood prosenchyma. Medullary rays are 2-6 seriate in *T. dioica*. In *T. orientalis* they are uniseriate and few. The soft bast forms a continuous ring in *T. orientalis*, while in *T. dioica* it occurs in groups opposite the xylem bundles.

The pith of *T. dioica* is formed of thick-walled cells, those near the periphery being filled with granules; it does not occur in *T. orientalis*.

Internal secretory organs in both the species are represented by some of the cortical cells near the periphery with tanniniferous contents.

ELATINEAE.

Bergia ammanioides *Roxb.*—Pl. VI, figs. 47, 48, 49. A small number of cells with clustered crystals occurring near the veins. Secretory cells with tanniniferous contents found in the pith. Clothing hairs not found on the leaf. Hairs on the axis in the form of very thin-walled uniseriate trichomes. Glandular hairs absent on the leaf and axis. T. S. of the axis quadrangular. Assimilatory tissue in the axis formed of chloroqhyll containing parenchyma. Sclerenchymatous pericycle in the form of small stone-cells at the angles. Medullary rays absent.

Bergia odorata *Edgew.*—Pl. VI, fig. 50; Pl. VIII, figs. 51, 52. A layer of polygonal cells with clustered crystalsin the middle of the mesophyll. Numerous clustered crystals near the veins. Secretory cells with tanniniferous contents in the cortical parenchyma, soft bast and pith. Ordinary unicellular hairs and uniseriate trichomes found on the leaf and axis. Glandular shaggy hairs occurring on the leaf and axis. T. S. of the axis circular. Assimilatory tissue in the axis composed of short palisade cells. Sclerenchymatous pericycle forming a loose ring of small groups of stone-cells. Medullary rays 1-2 seriate.

Structure of the Leaf:—The epidermis is composed mostly of horizontally tabular cells with very large water-storing cells intercalated amongst them. The water-storing cells are sometimes divided by cross walls into unequal halves, the lower half being much larger than the upper one. The inner walls are thin and arched convexly inwards, so as to come into close contact with the assimilatory tissue below. The lateral walls are thin and straight; the outer walls are flat and greatly thickened.

Stomata occur on both the surfaces, being a little more numerous on the lower. Guard-cells are elevated above the plane of the surrounding cells and the front cavity is a little raised above the surface. Stomata are surrounded by 3-4 ordinary epidermal cells.

The mesophyll is composed of short palisade cells on either side without a middle tissue except for a layer of polygonal cells containing clustered crystals in the middle of the mesophyll in *B. odorata.*

Internal secretory cells are not found in the leaf. Oxalate of lime occurs in the form of numerous clustered crystals near the veins. In *B. odorata* there is a layer of polygonal cells with clustered crystals in the middle of the mesophyll (fig. 51). In the axis clustered crystals occur in the cortical parenchyma and pith. Veins are provided with sheaths of green thick-walled cells. Larger veins are vertically transcurrent above and below by colourless parenchyma.

Hairy covering on the leaf and axis consists of clothing and glandular hairs. Clothing hairs are partly unicellular and partly uniseriate trichomes. They are not found on the leaf of *B. ammanioides* and those on the axis are very thin-walled. Glandular hairs occur only in *B. odorata* and are of a shaggy type; they are composed of a multicellular stalk and of a multicellular head (figs. 51, 52).

Structure of the Axis :—The epidermis is two-layered. Outer epidermal cells have outer walls greatly thickened, the lateral walls being thin. The stomata are like those on the leaf and are surrounded by 4-5 ordinary epidermal cells. The primary cortex is characterised in its outer portion by an assimilatory tissue, which in *B. odorata* (fig. 52) is composed of short palisade cells and in *B. ammanioides* (fig. 66) of chlorenchyma. Inner portion of the cortex is formed of large-celled cortical parenchyma.

The wood in both the species presents a quadrangular appearance. It is broader at the angles and is much narrowed between. Interfascicular wood prosenchyma is extensive. The medullary rays occur in *B. odorata* and are 1-2 seriate. The vessels are arranged in rows. Wood parenchyma is scantly developed.

The pith is composed of thin-walled cells. Internal secretory organs are represented by secretory cells with tanniniferous contents. They occur in the cortical parenchyma in the soft bast and pith of *B. odorata* and only in the pith of *B. ammanioides.*

MALVACEAE

Sida grewioides *Guill.*—Figs. 53, 54. Woody. Stomata more numerous on the lower surface. Internal glands numerous in the mesophyll. Clustered crystals occurring near the veins of the leaf and in the soft bast of the axis. Clothing hairs tufted and more

numerous on the lower surface. Glandular hairs pitcher-shaped and more numerous on the lower surface. Cortex characterised by cork and collenchyma. Assimilatory tissue formed of chlorenchyma. Bast fibres occurring in the soft bast. Wood uniformly broad. Medullary rays uniseriate. Pith formed of thin-walled cells.

Abutilon fruticosum *Guill.*—Figs. 55, 56. Woody. Stomata numerous on both sides. Internal glands absent. Clustered crystals found near the veins of the leaf and in the collenchyma, soft bast and pith of the axis. Clothing hairs tufted and equally numerous on both sides. External glands club-shaped and equally numerous on both the sides. Cortex characterised by cork and collenchyma. Wood uniformly broad. Vascular bundles occurring in the pith. Medullary rays 1-3 seriate. Pith formed of thick-walled cells.

Pavonia arabica *Steud.*—Woody. Stomata more numerous on the lower surface. Secretory cavities numerous in the mesophyll. Clustered crystals abundant in the leaf and axis. Clothing hairs tufted and more numerous on the lower surface. Tufted hairs along with simple thick-walled unicellular hairs found on the axis. Assimilatory tissue formed of chlorenchyma. Bast fibres occurring in the soft bast. Wood reduced on the lower side of the inclined axis. Medullary rays uniseriate. Pith formed of thin-walled cells.

Hibiscus micranthus *Lf.*—Pl. VIII, figs. 57, 58. Woody. Stomata more numerous on the lower surface. Internal glands absent in the leaf and axis. Clustered crystals found near the veins in the leaf, and in the collenchyma and pith of the axis. Clothing hairs tufted. External glands club-shaped and few on the leaf and axis. Assimilatory tissue formed of palisade cells. Cortex characterised by collenchyma. Sclerenchymatous pericycle and wood reduced on the lower side of the inclined axis. Medullary rays 1-3 seriate. Pith formed of thin-walled cells.

Gossypium herbaceum *L.*—Figs. 59, 60. Woody. Stomata more numerous on the lower surface. Internal glands in the leaf and axis in the form secretory cells and secretory cavities. Some of the pith cells holding tanniniferous contents. Clothing hairs tufted. Glandular hairs spherical and more numerous on the upper surface of the leaf and numerous on the axis. Cork subepidermal. Sclerenchymatous pericycle and wood reduced on the lower side of the inclined axis. Medullary rays 1-3 seriate. Pith formed of thin-walled cells.

Structure of the Leaf :—Epidermal cells are tabular with outer-walls thickened and papillose. Lateral walls are straight. The surface of the leaf in *Abutilon fruticosum* is characterised by ridges and furrows. There are cells of considerable dimensions with water-

storage function intercalated amongst the ordinary epidermal cells in *Hibiscus micranthus* (fig. 57A). They are present on both the sides and have their inner walls convexly arched inwards so as to come into close contact with the assimilatory tissue.

The stomata are more numerous on the lower surface. The front cavity is placed in a depression formed by the outer thickened and papillose walls. The guard-cells are in the plane of the surrounding cells as in *Abutilon fruticosum* and *Sida grewioides* (fig. 53), or they are elevated as in other species. The elevated position of the guard-cells can be accounted for by the occurrence of a dense covering of tufted hairs. The mesophyll is composed of palisade tissue on the adaxial side and of arm-palisade tissue on the abaxial side. The palisade tissue in *Sida grewioides* is formed of compact cylindrical groups. The mesophyll is characterised by the abundance of internal glands in *Sida grewioides*, *Pavonia arabica* and *Gossypium herbaceum*.

The internal secretory organs in *Gossypium herbaceum* are represented partly by some of the palisade cells and a layer of polygonal cells above the arm-palisade tissue with tanniniferous contents and partly by mucilaginous secretory cavities with a lining layer of cells, and situated in the middle of the mesophyll and in the arm-palisade tissue. In *Pavonia arabica*, there are mucilaginous secretory cavities situated in the middle of the mesophyll below the vascular bundles of the veins. In *Sida grewioides* (fig. 53), there are groups of loosely arranged palisade-like cells, faintly green in colour and placed between groups of palisade cells; there are also rounded or elliptical structures amongst the arm-palisade cells, also faintly green in colour. These structures in the mesophyll are either schizogenously formed internal secretory cavities or water-storage cells.

Oxalate lime occurs in the form of clustered crystals near the veins. In the axis clustered crystals occur in the cortex and pith of all species except *Pavonia arabica*. In *Sida grewioides* and *Pavonia arabica* numerous small-clustered crystals occur in the soft bast.

The veins are embedded except some of the larger veins in *Gossypium herbaceum* which are vertically transcurrent above and below partly by means of sclerenchyma and mostly by collenchyma. The veins are provided with bundle-sheaths of green thin-walled cells.

The hairy covering consists of densely placed tufted hairs. The rays are unicellular and are sunk directly in the epidermis, so that the hairs seem to be formed by a group of epidermal cells, fig. 55. The rays on the lower portion of the mid-rib are borne on a short multicellular stalk. The hairy covering is denser on the lower surface of the leaf.

Glandular hairs in *Abutilon fruticosum*, *Pavonia arabica* and *Hibiscus micranthus* (fig. 57) are club-shaped and are composed of a basal stalk-cell and of a head divided by horizontal and vertical walls. *Sida grewioides* (fig. 54) possesses pitcher-shaped uniseriate glandular hairs. External glands in *Gossypium herbaceum* (fig. 59) are spherical and are composed of a basal stalk-cell and of a head irregularly divided. External glands are numerous on both the surfaces of the leaf and are placed in depressions of the epidermis in all members except *Abutilon fruticosum*. They are more numerous on the lower surface in *Sida grewioides* and on the upper surface in *Gossypium herbaceum*.

Structure of the Axis :—The epidermis consists of small tabular cells with outer walls thickened and papillose. The lateral walls are straight. The hairy covering is composed of tufted hairs as described already. Besides the tufted hairs there are thick-walled unicellular hairs, resembling the rays of the tufted hairs, in *Pavonia arabica*. External glands occur on young branches and have the same characters as of those on the leaf.

The primary cortex is characterised by subepidermal cork in *Sida grewioides*, *Abutilon fruticosum* (fig. 56) and *Gossypium herbaceum* (fig. 60). Collenchyma occurs in the cortex in all members ; it may form long strands as in *Pavonia arabica* or a continuous ring as in other species. Assimilatory tissue consists of palisade cells in *Hibiscus micranthus* (fig. 54) ; in other species it is formed of chlorenchyma.

The pericycle is composed of closely placed rhomboidal groups of stone-cells ; it is reduced on the lower side of the inclined branches of *Hibiscus micranthus*. There are numerous small groups of bast fibres in the soft bast of *Sida grewioides* and *Pavonia arabica*.

The wood forms a composite hollow cylinder in all members. The vessels are small and arranged in closely placed rows. The interfascicular wood prosenchyma is not very extensive. The medullary rays are uniseriate in *Sida grewioides* and *Pavonia arabica ;* in others they are 1-3 seriate. In *Abutilon fruticosum* there occur vascular bundles in the pith close to the xylem cylinder. On a small portion of the axis in *Pavonia arabica*, *Hibiscus micranthus* and *Gossypium herbaceum* the wood is reduced ; in this portion of the axis the wood is much narrowed and vessels are few and small. This may be accounted for by the inclined nature of the axis, the wood being reduced on the lower side.

The pith consists of thick-walled cells in *Abutilon fruticosum ;* it is composed of thin-walled cells in others.

Internal glands occur in the cortex in the form of secretory

cavities with a lining layer of cells and with pinkish contents in *Gossypium herbaceum.* Oxalate of lime is found in the form clustered crystals in the soft bast in *Sida grewioides* and *Gossypium herbaceum* (fig. 60) in the cork, collenchyma, soft bast and pith of *Abutilon fruticosum* (fig. 56) and in the collenchyma of *Hibiscus micranthus* (fig. 58). Oxalate of lime does not occur in any form in *Pavonia arabica.*

Anamolous structures are represented by vascular bundles in the pith of *Abutilon fruticosum* as already mentioned.

General Review:—Epidermal cells are tabular with outer walls not much thickened. Large water-storing cells are intercalated amongst the ordinary epidermal cells in *Hibiscus micranthus* (fig. 57). Guard-cells are usually a little elevated. The front cavity is depressed. A dense covering of tufted hairs occurs on the leaves and young branches. External glands are either club-shaped (fig. 57), pitcher-shaped (fig. 54) or spherical (fig. 59); they are usually placed in epidermal depression.

The mesophyll is composed of palisade tissue on the adaxial side and of arm-palisade tissue on the abaxial side. Internal secretory organs occur in the leaf and axis in the form of secretory cells or secretory cavities. The veins are embedded except the larger ones in *Abutilon fruticosum;* they are provided with bundle-sheaths. Oxalate of lime is found in the form of clustered crystals in the leaf and axis. The assimilatory tissue in the axis is either composed of palisade tissue or of chlorenchyma. The cortex is usually strengthened by collenchyma. The cork is subepidermal. The pericycle is formed of rhomboidal groups of stone-cells. Numerous small groups of bast fibres are found in the soft bast of *Sida grewioides* and *Pavonia arabica.* The wood forms a composite hollow cylinder. The vessels are small and few. Interfascicular wood prosenchyma is not extensive. Medullary rays are 1-3 seriate. Vascular bundles occur in the pith of *Abutilon fruticosum.* The pith is formed of thin-walled cells.

STERCULIACEAE.

Melhania Denhamii *Br.* Figs. 61, 62. Lower surface of leaf deeply furrowed. Mesophyll formed of short palisade cells on the adaxial side and of arm-palisade ones on the abaxial side. Upper epidermal cells with tanniniferous contents. Numerous mucilage canals in the pith. Solitary crystals in the leaf and axis. Clothing hairs tufted. Glandular hairs club-shaped. Pericycle formed of an outer loose ring of stone-cells and of an inner loose ring of bast fibres. Vessels large. Medullary rays 1-3 seriate and broadening outwards in the form of wedges between the groups of soft bast.

Melhania magnifolia, Blatt. and Hall.

Lower surface of the leaf with furrows not deep. Mesophyll formed of palisade tissue on the adaxial side and of an arm-palisade tissue on the abaxial side. Numerous cells with tanniniferous contents near the veins. Solitary crystals occurring below the upper epidermis and near the veins of the leaf. Clothing hairs tufted. Glandular hairs club-shaped. Pericycle formed of a single loose ring of stone-cells. Vessels small and few. Medullary rays uniseriate. Mucilage canals in the pith few.

Structure of the Leaf:—Epidermal cells are tabular, with outer walls a little thickened and convexly arched outwards. Lateral walls are straight. The lower surface is characterised by furrows which are much deeper in *M. Denhamii*. Stomata are more numerous on the lower surface and occur in the furrows; they are surrounded by ordinary epidermal cells. Guard-cells are elevated and the front cavity is on a level with the surface. The mesophyll in *M. Denhamii* is composed of a homogeneous palisade tissue; in *M. magnifolia* there is a palisade tissue on the adaxial side and arm-palisade tissue on the abaxial side.

Internal glands are represented in the axis by cells with mucilaginous membranes in the cortical parenchyma and by numerous mucilage canals of schizogenous origin in the pith. In the leaf of *M. Denhamii* upper epidermal cells and numerous polygonal cells near the veins hold tanniniferous contents. Oxalate of lime occur in *M. Denhamii* in the form of solitary crystals near the veins of the leaf and in the cortical parenchyma and pith of the axis. In *M. magnifolia* bundles of solitary crystals occur near the veins and in a layer of tabular cells below the upper epidermis.

The veins are enclosed in green bundle-sheaths and are vertically transcurrent above by colourless parenchyma. The veins of the midrib are vertically transcurrent above by clourless thick-walled parenchyma and below by collenchyma.

Hairy covering on the leaf and axis consists of densely placed tufted hairs which are more numerous on the lower surface. The rays are unicellular and thick-walled and are sunk directly in the epidermis, so that the hairs seem to be formed by a group of epidermal cells (fig. 61). The rays on the lower surface of the mid-rib and on the axis are placed on a short multicellular stalk (fig. 62). The glandular hairs on the leaf and axis are club-shaped and are composed of a stalk-cell and a head divided by horizontal and vertical walls (fig. 62). The external glands are more on the upper surface and protect the palisade tissue against the strong light and glare by means of their secretions.

Structure of the Axis :—The epidermal cells are small and polygonal, with outer walls greatly thickened and convexly arched outwards. The cortex is characterised by subepidermal cork and by collenchyma. The assimilatory tissue is formed of chlorenchyma.

The pericycle in *M. Denhamii* is formed of an outer ring of groups of stone-cells and of an inner ring of radially elongated groups of bast fibres. The groups of stone-cells and of bast fibres are separated by colourless parenchyma. In *M. magnifolia* the pericycle is formed of a loose ring of groups of stone-cells.

The wood is composite and is much narrowed at two opposite points which probably represent the plane at right angles to that which is affected by the prevailing wind. The vessels in the broader portion are larger and less numerous. The wood in *M. magnifolia* is composite and is of uniform breadth. Interfascicular wood prosenchyma is extensive and is composed of cells with thick-walls and small lumina. Medullary rays in *M. Denhamii* are 1-3 seriate, broadening outwards in the form of wedges between the groups of soft bast and are in contact with parenchymatous cells separating the groups of stone-cells and of bast fibres. Medullary rays in *M. magnifolia* are uniseriate.

The pith is distinguished by the occurrence of mucilage canals and is composed of thin-walled cells.

TILIACEAE.

Grewia populifolia *Vahl.*—Front cavity placed in depressions formed by the thickened outer epidermal walls. Solitary crystals few and occurring near the veins and in the cortex. Veins vertically transcurrent above and below by sclerenchyma. Clothing hairs tufted. Glandular hairs club-shaped with the head divided by horizontal and vertical walls. Pericycle forming a composite ring of stone-cells. Medullary rays uniseriate.

Grewia villosa *Willd.*—Front cavity on a level with the surface. Solitary crystals numerous and occurring near the veins, in the cortex and pith. A few conglomerate crystals present near the veins. Veins vertically transcurrent above by sclerenchyma and below by bundle-sheath cells. Clothing hairs tufted. Glandular hairs club-shaped with the head divided by horizontal and vertical walls. Cork subepidermal with one or two layers of thickened and lignified cork-cells at its lower end. Pericycle formed of a composite ring of stone-cells. Medullary rays 1-2 seriate.

Grewia abutilifolia *Vent.*—Figs. 63, 64. Front cavity on a level with the surface. Solitary crystals few and occurring near

the veins and in the cortex. Veins vertically transcurrent above and below by sclerenchyma with water-storage tracheid-like structures at their terminations. Clothing hairs tufted and unicellular. Glandular hairs club-shaped with the head divided by horizontal and vertical walls. Pericycle of stone-cells and not composite. Medullary rays 1-3 seriate.

Corchorus trilocularis *L.*—Fig. 65. Clustered crystals near the veins and few. Glandular hairs club-shaped with the head divided by horizontal and vertical walls. Clothing hairs unicellular. Epidermis of the axis with outer walls considerably thickened and cuticularised. Lateral walls thickened. Wood narrowed on the lower portion of the inclined axis. Medullary rays uniseriate.

Corchorus antichorus *Raens.*—Clustered crystals near the veins and few. Clothing hairs unicellular. Glandular hairs club-shaped with the head divided by horizontal and vertical walls. Epidermis of the axis with the outer walls greatly thickened and cuticularised. Lateral and inner walls also a little thickened. Medullary rays 1-2 seriate.

Corchorus tridens *L.*—Figs. 66, 67. Clustered crystals near the veins and numerous. Clothing hairs unicellular. Glandular hairs club-shaped and with the head divided by horizontal walls. Epidermis of the axis with outer walls greatly thickened and with lateral and inner walls also a little thickened. Medullary rays 1-2 seriate.

Structure of the Leaf:—The epidermis of the upper side consists of almost cubical cells and of the lower side of horizontally tabular cells. The outer walls are a little thickened; the inner and lateral walls are thin. The lateral walls are straight. Epidermal cells surrounding the stomata are usually much smaller and are of the nature of subsidiary cells.

The stomata are more numerous on the lower surface, while in species of *Grewia* they occur only on the lower surface. The guard-cells are elevated and the front cavity is on a level with the surface. In species of *Corchorus* epidermal cells on either side of the guard-cells are elevated and are much smaller than the ordinary epidermal cells; they seem to be of the nature of subsidiary-cells. The stomata on the axis are like those on the leaf.

The mesophyll is composed of palisade tissue on the upper side and of arm-palisade tissue on the lower.

Oxalate of lime occurs in the form of numerous clustered crystals near the veins in species of *Corchorus* (fig. 66). In species of *Grewia* solitary crystals are found near the veins (fig. 63), and in the cortex and

pith. Solitary crystals are sometimes found in groups of 3-4 in the cells; they are sometimes also aggregated in the form of conglomerate crystals in the axis of species of *Grewia*.

The veins are embedded and are not provided with bundle-sheaths in species of *Corchorus*. The veins are vertically transcurrent above and below by sclerenchyma in *Grewia populifolia* and *Grewia abutilifolia* and above by sclerenchyma and below by sheath cells in *Grewia villosa*. The veins in species of *Grewia* are provided with bundle-sheaths. In *Grewia abutilifolia* there are structures of the nature of water-storing tracheids at the terminations of the veins.

Hairy covering on the leaf and axis consists of clothing and glandular hairs. The clothing hairs in species of *Corchorus* are unicellular, thick-walled and not dense (fig. 66). In *Grewia* they are tufted (figs. 63, 64), the constituent rays being unicellular and thick-walled. Besides the tufted hairs, there are unicellular thick-walled hairs, resembling the rays of the tufted hairs, on the axis of *Grewia abutilifolia* (fig. 63). The glandular hairs are club-shaped and are composed of a stalk-cell and of a head divided only by horizontal walls (figs. 65, 63), or by both horizontal and vertical walls (fig. 64).

Structure of the Axis :—The epidermis in species of *Corchorus* consists of horizontally tabular cells with outer walls thickened and arched convexly outwards, the thickening of the outer walls being quite considerable in *Corchorus trilocularis* and *Corchorus tridens*. The lateral and inner walls are also thickened. The epidermal cells in species of *Grewia* are horizontally tabular and are uniformly thickened on all sides. The lateral walls are straight in members of both the genera.

The cortex is characterised by subepidermal cork in species of *Grewia*, the innermost layers of which in *G. villosa* are composed of thickened and lignified cork-cells. Cork does not occur in species of *Corchorus*. Three tissues may be distinguished in the cortex: in species of *Corchorus* outermost parenchyma, middle collenchyma and innermost parenchyma; in species of *Grewia* outermost cork, middle collenchyma and innermost parenchyma.

Internal secretory organs are represented in the axis of members of both the genera by mucilage cavities in the cortical parenchyma (figs. 67, 64) and in the pith (fig. 64).

The pericycle is composed of closely placed groups of stone-cells with very small lumina (figs. 64, 67). The wood forms a composite hollow cylinder. The vessels are arranged in rows. The interfascicular wood prosenchyma is extensive and is composed of cells with wide lumina. The medullary rays are numerous; they are uniseriate in *C. trilocularis*, *G. populifolia* and *G. villosa*, 1-2 seriate in *C.*

anti-chorus and *C. tridens* and 1-3 seriate in *G. abutilifolia.* Wood parenchyma is poorly developed.

The wood in *C. trilocularis* is narrowed on one side, the narrowed portion being characterised by a larger number of vessels and the broader portion by more extensive wood prosenchyma. These modifications in the structure of the wood may be the result of the inclined nature of the axis, the narrowed portion being situated on the lower side of the inclined axis. The abundance of wood prosenchyma on the upper side prevents the axis from bending.

The pith is composed of thin-walled cells in species of *Corchorus* and of thick-walled cells in species of *Grewia.*

General Review :—There are a number of characters which can be used for the diagnosis of the two genera.

Corchorus :—Stomata with smaller epidermal cells on either side of the guard-cells. Oxalate of lime in the form of clustered crystals near the veins. Veins embedded and not provided with bundle-sheaths. Clothing hairs unicellular. Outer walls of epidermal cells of the axis greatly thickened and cuticularised. Cortex composed of three zones—outermost parenchyma, middle collenchyma and innermost parenchyma. Pith composed of thin-walled cells.

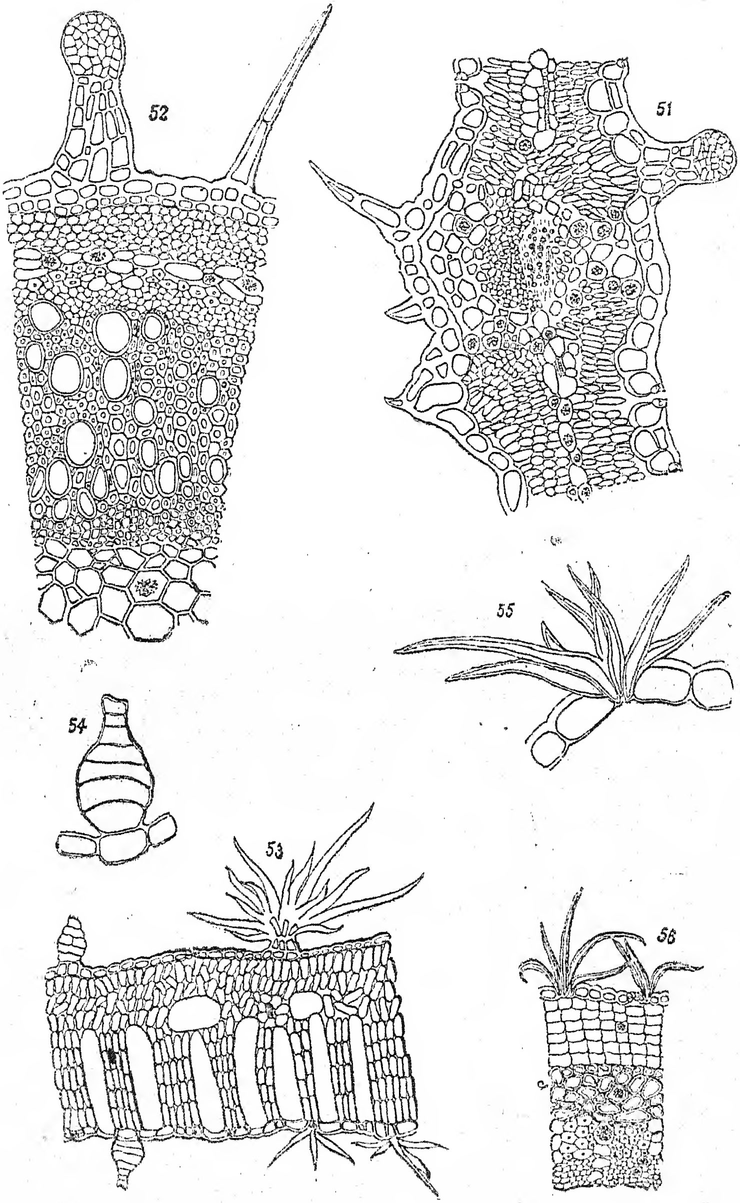
Grewia :—Stomata with ordinary epidermal cells on either side of the guard-cells. Oxalate of lime in the form of solitary crystals. Veins vertically transcurrent and provided with green bundle-sheaths. Clothing hairs usually tufted. Epidermal cells of the axis uniformly thickened on all sides. Cortex composed of three zones—outermost cork, middle collenchyma, innermost parenchyma. Pith formed of thick-walled cells.

(*To be continued.*)

Plate VII

51-52. *Bergia odorata.*
51 T.S. of the leaf.
Oc. 3 ; Ob. C.
52 T.S. of the axis.
Oc. 3 ; Ob. C.
53-54. *Sida grewioides.*
53 T.S. of the leaf.
Oc. 6 Com. ; Ob. 8 mm. Ap.
54 Glandular hair on the leaf.
Oc. 6 Com. ; Ob. 3 mm. Ap.
55-56. *Abutilon fruticosum.*
55 Hair on the leaf.
Oc. 6 Com. ; Ob. 3 mm. Ap.
56 T.S. of the axis.
Oc. 6 Com. ; Ob. 8 mm. Ap.

N.B.—To get the original dimensions multiply by 1·7.



T. S. Sabnis del. PLATE VII.

Plate VIII

57-58. *Hibiscus micranthus.*
57 T.S. of the leaf.
Oc. 4 Com.; Ob. 3 mm. Ap.
58 T.S. of the axis.
Oc. 4 Com.; Ob. 8 mm. Ap.
59-60. *Gossypium herbaceum.*
59 Glandular hair on the leaf.
Oc. 6 Com.; Ob. 3 mm. Ap.
60 T.S. of the axis.
Oc. 4 Com.; Ob. 8 mm. Ap.
61-62. *Melhania Denhamii.*
61 T.S. of the leaf.
Oc. 6 Com.; Ob. 8 mm. Ap.
62 Hair on the axis.
Oc. 6 Com.; Ob. 8 mm. Ap.
63-64. *Grewia abutilifolia.*
63 T.S. of the leaf.
Ob. 6 Com.; Ob. 8 mm. Ap.
64 T.S. of the axis.
Oc. 4 Com.; Ob. 8 mm. Ap.
65. *Corchorus trilocularis.*
Glandular hair.
Oc. 6 Com.; Ob. 3 mm. Ap.
66-67. *Corchorus tridens.*
66 T.S. of the leaf.
Oc. 6 Com.; Ob. 8 mm. Ap.
67 T.S. of the axis showing the epidermis and cortex.
Oc. 6 Com.; Ob. 8 mm. Ap.

N.B.—To get the original dimensions multiply by 1·7.

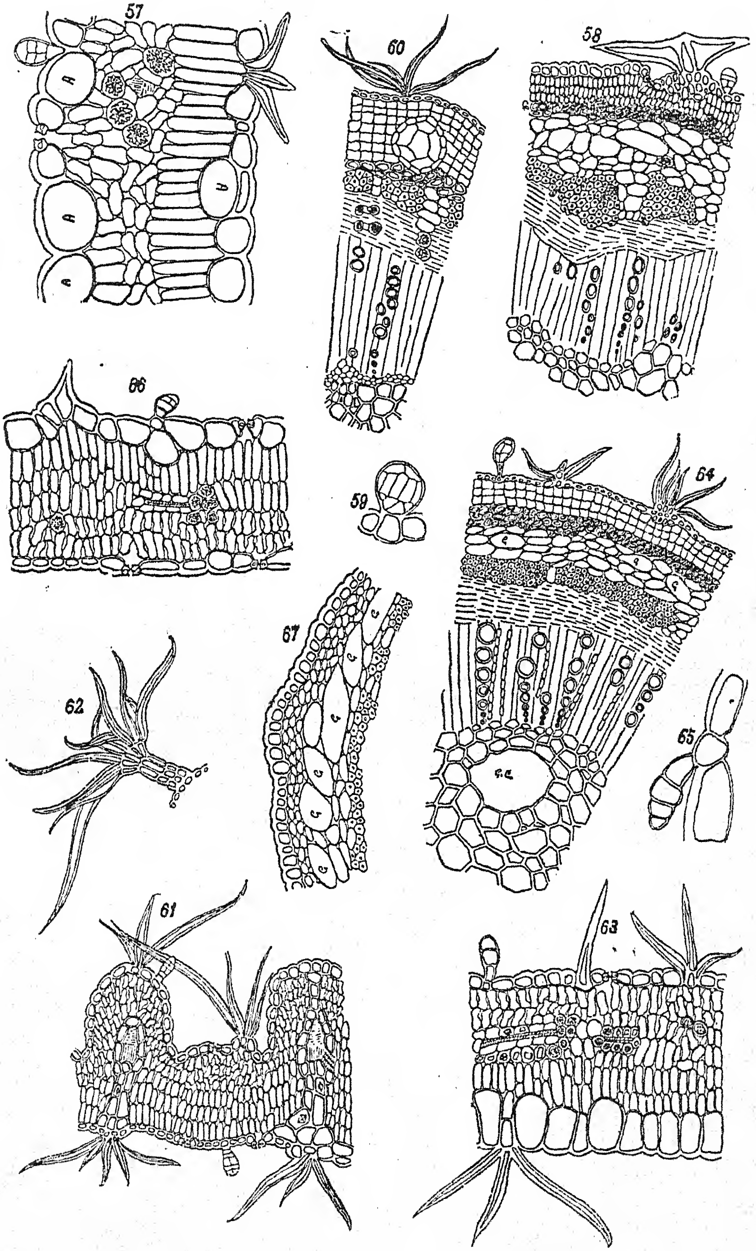


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PLATE VIII.

[illegible] D.Sc. F.N.I

Vice Chancellor

ABNORMAL NUMBER OF NEEDLES IN THE SPURS OF PINUS LONGIFOLIA

BY

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Pinus Longifolia is a common connifer of the outer hills of the Punjab Himalayas and is often cultivated in the plains. The number of leaves in the dwarf shoots in this species is described in the Indian Floras[1] as three. So constant is this number in the *adult* plant that the writer has not come across a single example of a different number during many years for which the plant has been a subject of study in the Botany classes at the Lahore Government College and in spite of a careful examination of several trees recently. It came as a surprise therefore when, last year, while examining a seedling he came across an abnormality in this respect quite by chance. On examining the seedling further and later on examining more seedlings many such instances were found. On looking up the literature[2] of the subject it was found that the abnormal number of needles in the spurs of many species both in the seedling and the adult plant is by no means rare though no mention of *Pinus longifolia* has been met with anywhere. Among a pretty large number of species mentioned by Thomson (Botanical Gazette, May, 1914) in this connection, *Pinus excelsa* is the only Indian species. Again although a number of observations are recorded in the papers mentioned yet the writer has not come across any quantitive study of this subject. This paper records a short study of this kind.

In order to find out the relative frequency of plants with abnormal spurs as regards the number of needles and the relative number of different kinds of such spurs on the same plant one hundred and one seedlings were taken from the nursery of the Lawrence Gardens, Lahore, through the courtesy of the Superintendent, and carefully

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[1] Hooker: *Flora of British India;* Brandis: *Indian Trees,* also his *Forest Flora ;* Parker: *Forest Flora of the Punjab,* etc. Among other standard books on this subject may be mentioned Elwes and Henry: *The Trees of Great Britain and Ireland.*

[2] Thomson, R. B.: The Spur Shoots of the Pines. *Bot. Gazette, May, 1914.* Dufrenoy, J.: Pine Needles, Their significance and History. *Bot. Gaz., November, 1918.* Reference to other literature bearing on this point is given in these papers.

examined as regards their general condition, height, branching, dwarf-shoots, etc., by L. Ram Lal Sethi, M.Sc., Demonstrator of Botany at the Government College. As he had to leave for Europe immediately after the completion of these observations the writer looked up the literature and prepared the analysis. The seedlings were about four years of age and varied in height from 11 inches to 22 inches. All the plants had been kept under the same conditions along with many others.

As is well known young seedlings bear only scattered green leaves and scale-leaves and dwarf-shoots are developed only gradually. Of the 101 seedlings one did not possess any dwarf-shoots at all and was unbranched. Otherwise the plant was erect and healthy so far as could be seen. No further notice will be taken of this plant. All the remaining one hundred possessed dwarf-shoots and a great many possessed long shoots in addition. No plants were found with abnormal shoots only, but normal and abnormal shoots were mixed in more than one half, 57 per cent. to be exact. The abnormal number of needles was 2, 4 or 5. No spur was found with 1 or more than 5 needles. The analysis is given below :—

Plants examined : 100. All with dwarf-shoots.

Plants with 3-leaved shoots only		43
Plants with abnormal shoots in addition to 3-leaved shoots		57
Plants with 2-leaved abnormal shoots only	2	
Do. 4-leaved abnormal shoots only	40	
Do. 5-leaved abnormal shoots only	2	
Do. 2-and 4-leaved abnormal shoots	6	57
Do. 2-and 5-leaved abnormal shoots	0	
Do. 4-and 5-leaved abnormal shoots	3	
Do. 2—4-and 5-leaved abnormal shoots	4	

It will be seen from the above that plants with 4-leaved abnormal shoots only are by far the most common. If we add to these the plants that bear 4-leaved shoots in addition to other abnormal shoots the number becomes still larger, *i.e.*, 53. The relative number of shoots is given below :—

Plants examined : 100 as above, of which 57 possessed abnormal shoots.

2-leaved shoots in all the plants	17
4-leaved shoots in all the plants	145
5-leaved shoots in all the plants	11

It is clear that the 4-leaved shoots are by far the most common of all the abnormal shoots. It may be mentioned here that the number of 3-leaved shoots on these plants was very variable. It ranged from a few to about 300 on each plant.

The co-relation of the presence of the long shoots to the number of abnormal dwarf shoots is shown below :—

Plants with long shoots (branched)		90
Plants without long shoots (unbranched)... ...		10
Plants with normal shoots only	5	10
Plants with abnormal shoots also	5	

It will be seen from this that 50 % unbranched plants show the presence of abnormal shoots in addition to the normal shoots, while 52 out of 90, *i.e.*, nearly 58 %, of branched plants possess the same peculiarity. This small difference has probably no significance. A very interesting point, however, is that that all the abnormal shoots on these 5 plants were 4-leaved. The details are as follows :—

Two plants possessed only one such shoot each; one possessed 5 such shoots; one possessed 8 such shoots, and one possessed 13 such shoots. This last plant was growing in a larger pot than the others.

This relation between the absence of long shoots and the presence of 4-leaved abnormal dwarf shoots only (of course in addition to normal shoots) can hardly be accidental. Of course some branched plants also had 4-leaved shoots, either alone or along with other abnormal shoots, but no unbranched plants were found with any but 4-leaved abnormal shoots. The large size of the pot in one case may explain the large number of the 4-leaved shoots in that plant, but hardly the fact that all shoots were 4-leaved and not even one 5-leaved. Another fact which was noticed in this connection was that plants with few and small branches showed a greater tendency on the whole to form abnormal shoots than plants with long and many shoots but no exact numbers were obtained.

Below is given an analysis of the plants which possessed *five or more* abnormal shoots. The total number of such plants was 12. Nine plants had purely 4-leaved shoots as follows :—

4 with 5 such shoots.

1 with 7 such shoots.

2 with 8 such shoots.

1 with 10 such shoots.

1 with 13 such shoots.

A combination of 2-and 4-leaved shoots with more than five shoots occurred in one plant :—2-leaved shoots, 2; 4-leaved shoots, 5.

A combination of 4-and 5-leaved shoots with more than five shoots occurred in one plant :—4-leaved shoots, 8; 5-leaved shoots, 3.

A combination of 2-, 4-and 5-leaved shoots with more than five shoots occurred in one plant :—2-leaved shoots, 1; 4-leaved shoots, 7; 5-leaved shoots, 1.

As regards the position of the abnormal shoots on the plant no special relationship could be found. They occurred scattered on the plant. This point is also referred to take on in the paper.

The length of the needles of the abnormal shoots was also measured but no special relationship with the length of the needles of the normal shoots could be made out.

It will be seen from what has been described before that 4-leaved spurs are by far the most common of abnormal shoots in the seedlings of *Pinus longifolia* forming as they do 83·8 % of the whole lot of abnormal shoots. The actual numbers observed in one hundred plants were 145 out of 173. The numbers of 2-leaved and 5-leaved shoots were 17 and 11 respectively. (The normal number of leaves in the dwarf shoot is three and according to the observations of the writer variations in the adult plants is extremely rare.) The seedlings show therefore that a very great majority of abnormal shoots possess a larger number of leaves than the normal shoots. This is contrary to the observations of Thomson who says (Bot. Gaz., May, 1914):—" It is more usual to find the spurs poorly developed when they first appear on the seedling . . . . This feature shows itself especially in species which have normally more than two leaves in the mature condition." Out of the 57 plants with abnormal shoots only two possessed 2-leaved abnormal shoots only, and ten more which possessed 2-leaved shoots in addition to other forms of abnormal shoots did not show that the 2-leaved shoots were in every case the first formed abnormal shoots. In one the only 2-leaved shoots present was near the top above some other abnormal shoots, but in the other nine the shoots were near the base.

The writer is however in perfect agreement with the conclusion arrived at by Thomson when he says:" The lack of definiteness in the number of leaves in a fascicle, and the occurrence of supernumerary needles in the recognised primitive region and after wounding, are evidence of the branch character of the spur of the pines." He points out also that the normal proliferation of the spur in the seedling and young plant into an ordinary branch with both primordial and fascicled leaves, and the traumatic revival of this condition in the mature tree place this conclusion beyond reasonable doubt, strengthened as it is by the normal occurrence of the spirally arranged leaves in the seedling and other facts.

According to this view it would also appear that species of pine possessing a smaller number of leaves in their spurs are more specialised than the others and the tendency has been towards forming spurs with fewer and fewer leaves. This conclusion is also supported by the facts reported by Boodle (New Phytologist, 1915):—" In

Pinus monophylla the spur shoots as a rule bear each a single needle, but two are occasionally present. Masters found by studying early stages that two leaf-rudiments are always produced, but that one of them generally becomes arrested at an early stage."

A paper on the comparative anatomy of the needles of the seedlings and mature plants is in preparation.

The main conclusions of the paper may be stated as folllows :—

1. Spurs with more or less than three needles in the adult plants of *Pinus longifolia* as seen in Lahore are extremely rare.

2. Spurs with more or less than three leaves are very common in seedlings. Fifty-seven per cent. seedlings possesses such abnormal spurs.

3. Spurs with 4-leaves are the commonest of all, being 83'8 % of all abnormal shoots.

4. The conclusion is drawn from these facts that a 3-leaved spur has been derived from a spur with more leaves, that the spur is equivalent to an ordinary shoot and that pines with a small number of needles in their spurs are more highly specialised than species with a larger number of needles.

ON THE USE OF THE TERM "VARIETY" IN SYSTEMATICS.

BY

L. J. SEDGWICK, F.L.S.

The remarks which follow are based on practical experience as a field worker only, and the writer hopes that readers of the Journal will accept this limitation when considering them. The main questions brought up for discussion are: (1) whether the term *variety* as used in our Floras is applied to one natural phenomenon only, or at the worst to several phenomena which are perfectly homologous, and if not, then (2) whether there is any way of separating out the various phenomena hitherto confused under the one term, and assigning to each a separate term; since it is clearly unscientific to use one and the same term for phenomena which are heterologous.

It is usually assumed that in all taxonomic work the personal equation enters largely, and cannot be eliminated. It is open to question whether the latter part of this assumption is correct so far as species and units lower than the species are concerned. So far as concerns genera, families and all units above the species, since these taxonomic divisions are based on assumed descent, and since for the descent of plants our only material is the very fragmentary palæontological record, it is clear that our results must largely depend upon guess work. And it is for that reason that the tendency of even our deepest systematic thinkers to allow their generic divisions to be (sometimes at any rate) influenced by considerations of convenience is a comparatively venial sin. In the case of species however and all intra-specific units—excluding of course extinct species—there is no possibility of pleading lack of evidence. If into our discrimination of species the personal equation enters the fault is ours. We are hampered by weakness of power of perception, by shortage of workers, by lack of time, and by idiosyncrasies that could be eliminated. But the truths are there if we could only unravel them. In the case of most "critical" species the number of available individuals is legion. Mendelian and other experiments could be carried out. Even if the species or group of species is in an active state of evolution at the moment its different forms and developmental tendencies could be enumerated and charted. For instance, to take an imaginary case of an Indian genus believed to be in an active condition of

evolution, if the State cared to engage 100 trained observers to collect, observe and measure, and 10 trained systematists to examine and collate results for five years, facts would emerge at the end which would establish, at any rate for the time being, the limits of species and lower units and their developmental tendencies. The writer is not for a moment advocating such a course of action as a practical way of spending the State finances! The illustration is merely given by way of showing that so long as the evidence is completely available no problem is absolutely beyond solution. In short, where we find in the floras so-called "critical species" their critical character is due to human infirmity, and is not absolute.

Generally speaking all Indian workers seem to find that where the Flora of British India gives many *varieties* a mixture of species may be suspected, which patient collecting and collection of material will (and as a fact often does) clear up. Conversely it must be admitted that some species in the Floras can be broken down by patient collection of transitional series. Those two facts would go a long way towards establishing the truth of the proposition enunciated in the preceding paragraph. But unfortunately, partly owing to post-Linnæan and especially modern Mendelian researches into the origin of species, and partly owing to the extremely minute examination to which certain particular genera have been subjected in the West, and the recognition thereby of numerous intra-specific forms, there has been of late years a strong tendency to cast scorn upon Systematics, and even to take the final step of asserting that the individual is the only ultimate unit. Fortunately, however, both the economist who obtains products from plants and the field-worker who observes and collects them, know that the individual is only the unit in the same sense that no two members of one nation or even of one household are exactly alike, and that just as human beings can be and must be grouped into larger units on various scientific and social basses, so among plants there are units containing millions—often countless millions—of individuals, whose common characters can and must be described, and to which the application of a "barbarous binomial" is both convenient and necessary.

The unit commonly accepted and used for more that a century and a half is the Linnæan species. And it is this particular unit upon which some students of genetics to-day seem to cast such scorn, regarding it as an erroneous conception and no true phenomenon. Now this view is one which the writer believes to be wrong. The practical field-worker knows that in a region with which he is familiar he can at once assign to their Linnæan species all but an

infinitesimal fraction of the plants that he sees around him. Of that fraction many are simply freaks or sports; and as there is a tendency for such freaks to be collected and to find their way into herbaria it follows that herbaria may often give an exaggerated impression of the range of variability of species generally. Into the genetic phenomenon of freaks this paper cannot enter.

Over and above freaks we have to recognize a number of other types of variability.

First there is the phenomenon of geographical change, which may be either gradual or sudden. As an example of the first, the colour of the spikelets of many *Cyperaceæ* and *Gramineæ* is paler in North India and gradually darkens as one goes south, until on the Nilgiris it is almost black. As an example of the second, *Ageratum conyzoides* Linn. is on the Nilgiris a delicate-stemmed plant with pure mauve flowers, while in the Dharwar District of the Bombay Presidency it is a coarse-stemmed and coarse-leaved plant with dirty white flowers. The causes of geographical change are very obscure. Complex climatic factors have to be reckoned with, as well as geological formations. There is also the phenomenon of isolation of " lines, " which are discussed below.

Secondly there is a type of variability of a purely edaphic character within the same geographical region. Thus *Flueggea leucopyros* Willd. would seem to be merely an edaphic (xerophytic) form of *F. microcarpa* Bl.; *Leucas montana* Sr. would seem to be the xerophytic form of *L. mollissima* Wall. The various edaphic forms of many species not hitherto split off by the Floras are well known.

Thirdly there are distinct cases of variability in life-period. Thus *Fimbristylis diphylla* Vahl., a perennial, has an annual form var. *annua* (sp.) R. and S.: and similarly *Cyperus Iria* L. (see p. 693 of Journ. Bom. Nat. Hist. Soc. Vol. XXV No. 4). *Cyperus flavidus* Retz. would seem to be only an annual form of *C. Haspan* L.

Fourthly there would seem to be plants which exhibit a sort of seasonal dimorphism, not of course homologous with the same phenomenon in insects. Thus some species of *Smithia* have small flowers when they mature in the rains and large ones when they mature in the dry weather. *S. flava* Dalz. (var. in Cooke. F. Bom. Pres.), if not a valid species is apparently a seasonal form of *S. sensitiva* Ait.; while last winter the writer found at Yellapur in North Kanara a plant which corresponded exactly with *S. bigemina* Dalz. except that it was much larger in all its parts especially the flowers, and had matured in the winter instead of the rainy season.

Fifthly there is the much more difficult phenomenon of " lines ". That these are due to the interplay of Mendelian characters is now

apparently established. As said above; geographical changes of an abrupt type are probably caused by isolation of lines. The result of isolating lines is well seen in the cultivated cereals. In natural conditions isolation is much less frequent; in fact it would not be too much to say that Nature abhors a pure line, just as she abhors the inter-specific cross. And it is these two facts alone which secure the stability and continuity of the Linnæan species. Nevertheless varieties due to isolation of lines without geographical isolation almost certainly do occur,—for instance *Scirdus supinus* var. *uniondis* Cke, and *Cyperus Iria* var. *paniciformis* Cke.

Sixthly there are the not infrequent cases of species and genera which are in an active state of evolution, producing a maze of forms among which clear specific lines of demarcation are not discernible. These forms may be the De Vriesian mutants. It would be beyond the scope of this paper to discuss this point; but it is necessary for the argument to say that whereas "lines" seem to be the product of isolation and combination of already existing, stable allelomorphs, the changing evolutionary forms now referred to would seem to be caused by instability of the allelomorphs themselves, which in such cases are disappearing and reappearing with changed properties.

Seventhly (although they stand on quite a different footing) it is necessary to refer to inter-specific hybrids, which though normally abhorred by Nature, do occur, and will ultimately be detected in India as they have been in Europe.

Now, omitting hybrids, our floras have for the most part in the past called all these varied forms of whatever origin by the one word variety. It is true that in cases of species with a very great range of variability the forms have sometimes not been given a varietal name, but simply listed under numbers or letters. But it would appear that this has been due more to convenience than to a clear discernment of the different phenomena.

Before considering the use of terms for units below the species it is desirable to consider whether we are justified in using the same term "species", undifferentiated, for the Linnæan group of individuals in which the allelomorphs are stable as well as for those in which they are unstable. The writer would suggest that the two phenomena be distinguished as "*species* (*constans*)", *and* "*species inconstans*", omitting in practice the word *constans*.

For units below the species the following scheme is suggested :—

A. For freaks or sports no special term, each one to be separately described.

B. (1) For geographical forms, where sharply distinguishable, the trinomial system now used by ornithologists.

(2) For edaphic forms the term *varietas* followed by the ordinary ecological term such as *xerophytica halophytica*, etc.

(3) For life-period forms *varietas annua, biennia*, etc.

(4) For seasonal forms *varietas hyemalis, aestivalis*, etc.

(5) For "lines" *varietas Mendeliana* followed by the letters of the Greek alphabet.

(6) For forms of inconstant species *forma* is the ultimate unit, to be grouped about recognizable lines of evolution in various ways. For this case it is not possible to suggest hard and fast rules. The study of these inconstant species is a special one, for which the name micro-systematics might be used. A good many European and American genera have been studied in minute detail, and recently *Ammannia* and *Rotala* in India by Blatter and Hallberg in Journ. Bom. Nat. Hist Soc.

C. For hybrids the usual multiplication sign.

It will be argued that we do not know which variant forms are to be assigned to which class in the above scheme. And this is true. But temporary ignorance is no valid excuse for continuing to confuse under one term phenomena which are not homologous. Gradually the truth will emerge.

SHORT NOTES ON DISTRIBUTION, ETC.

I had an opportunity of running through some of Mr. P. F. Fyson's plants recently collected in the Nilgris and I find two of them rather interesting.

Juncus bufonius *Linn.* so far known to occur only in Northern India from the plains to 13,000 ft. in the Himalayas, is a new find at 7,000 ft. in a marsh 6 miles out of Ootacamund. This plant like a few other adds to the 'floristic affinity' which to a certain extent exists between the Nilgiris and the Himalayan region. Fruiting in September.

Pyrenacantha volubilis *Hook.* A dioecious climber which has thus far been recorded in the Madras Herbarium from Kambakkam (Chingleput), Madura and Tinnevelly hills and noted in Gamble's Madras Flora as collected only in the Pulney and Tinnevelly hills, also hails from Kallar at 1,500 ft. on the Nilgris. The piece collected is of a male plant. Flowers in October.

16-10 19. C. TADULINGAM.

Impatiens Tangachee *Bedd*—in Gamble's new Flora of the Madras Presidency is given as occurring on the Western Ghats, in river beds on the higher slopes of the Annamalais, above 4,000 ft. and in the 'Bolumpatti Hills of Coimbatore.' Fourteen years ago I was shown the plant growing in a stream at about 5,000 ft. on the Pulneys, by an enthusiastic amateur collector, who pointed out that as it was rare it would be well not to make its whereabouts known generally. Dr., now Sir Alfred, Bourne had also collected the species from the same stream, in 1899.

Heterocarpus *Wight*—was a genus differing from *Commelina* mainly in the fruit, of which one cell contains one seed only and remains indehiscent and attached to the pedicel, the other two cells each with two seeds falling away. Last year I collected on the higher downs of the Pulneys two plants, identical in every way except that one is hairy all over and the other glabrous, of a blue flowered *Commelina* which Mr. C. C. Calder, of the Royal Botanic Gardens, Calcutta, tells me are undoubtedly Wight's *Heterocarpus glaber* and *H. hirsutus:* but points out that according to Wight the flowers are yellow. I find on enquiry at the herbarium in Coimbatore that the species of *Heterocarpus, H. glaber*, collected in Palghat (Wight's locality) is certainly yellow or orange. A specimen of

what has been taken to be Wight's *H. hirsutus* has rather broader leaves than Wight's illustration, (Ic. Pl. In. Or. t. 2067) shows but is probably the same species, and the illustration might have been drawn from my plant. (Comp. the plate opposite). It would seem therefore that Wight's *H. hirsutus* and perhaps also *H. glaber*, has orange flowers on the lower slopes and blue flowers on the higher, and that they are two varieties a glabrous and a hairy of one species. A change from pink or purple to blue is common enough but orange and blue are not as a rule I believe, interchangeable, a blue colour being usually in the cell sap, but an orange in plastids. Possibly we have in these four plants two pairs of Mendelian allelomorphs segregating; hair and their absence, and orange and blue colours. Both forms were abundant where I found them, and growing side by side.

It would be interesting therefore to know whether there are any cases known of a species having blue flowers in one place and orange flowers in another.

The flowers of **Hydnocarpus alpinus** *Wtk* are typically dioecious. Recently I found near Coonoor a single male flower on a female tree, with pistillate flowers and fruits above and below on the same branch. Such an occurrence is probably not uncommon, though seldom recorded. Davy and Gibson described*, the occurrence of both sexes on the same plant of *Myrica Gale* a typically 'unisexual' dioecious species, and what, was more interesting, observed a change from maleness to femaleness between one year and the next on more than one plant.

Ever since the discovery of chromosome reduction we have been compelled to consider higher plants and ferns as never really sexual at all, sex appearing only in the last divisions of the cells which produce the pollen grains and ovule respectively. But where the flowers are unisexual the visible 'sex' may be dependent on external conditions, and is known to be affected sometimes by parasites. The object of this note is to call attention to this, for in India we have many plants with unisexual flowers *e.g.* spp. of sterenlic, Terminalia, Piper, Myristica and observations of these, from year to year, by those in a position to make them, might lead to the discovery of the conditions which affect 'sex' (though if as seems likely sex is a Mendelian character, only in heterozygous individuals) or in the relative numbers of male and female flowers, with results perhaps of both scientific and economic importance.

P. F. Fyson.

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* Davy, A. J., and Gibson, C. M. Note on the Distribution of Sexes in *Myrica Gale New Phyl. XVI* (*1917*), *pp. 147—151.*

D. R. Fyson del. COMMELINA sp.

CONTRIBUTIONS TOWARDS A FLORA OF BALUCHISTAN.

From materials supplied by Col. J. E. B. Hotson, I.A.R.O.

BY

E. Blatter, S.J., Prof. F. Hallberg and C. McCann.
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(Continued from last issue)

Geraniaceae—(*Cont.*)

Erodium sp. (*sine fructu*). Loc.: Garmkan, 1 mile NE of Panjgur, about 3,125 ft. (no. M 163). Fl. in March 1918.

Rutaceae.

Ruta *L.*

Ruta villosa *M. B. Taur. Cauc. 310.* Loc.: Pirandar, 205 miles SSW of Kalat, about 1,500 ft. (no. M 262). Fl. in Sept. 1917.
Vern. Name: Gandarim (Bal. Br.).

Ruta stocksiana *Burkill Fl. Pl. Baluchistan (1909) 17.* Loc.: Rek Chah, 11 miles E. of Chambar (Kolwa), about 1,800 ft. (no. M 268). Fl. in April 1918. *Vern. Name:* Sadaf (Bal.), Gandarim (Br.).

Ruta tuberculata *Forsk. Fl. Aeg. Arab. 86.* Loc.: Khozdar, 27° 48′ N., 66° 37′ E., about 4,100 ft. (no. 341). Fl. in Sept. 1917.
Vern. Name: Sadap (Bal. and ? Br.).

Meliaceae.

Melia *L.*

Melia azedarach *L. Sp. Pl. (1753) 384.* Loc.: Nal. 27° 41′ N. 66° 13′ E. 3,834 ft. (no 339, 339A).
Vern. Name: Bakkan (Br.), Bakan (Bal.)

Celastraceae.

Gymnosporia *W. & A.*

Gymnosporia spinosa *Fiori Bos. e Pint. legn. Eritrea (1909) 225* (G. montana *Benth*). Loc.: Rar Kaur, about 165 miles S. by W. of Kalat, 4,000 ft. (no. 120B). Fl. in Sept. 1917.
Vern. Name: Kotor (Br. Bal.).

Gymnosporia royleana *M. A. Laws. in Hook. f. Fl. Brit. Ind. I, 620.* Loc.: Hills S. of Chambar (Kolwa), 26° 9′ N. 64° 42′ E., about 1,900—2,300 ft. (no. M 76 B); Bagai Daf (Mantar), about 42 miles S. of Panjgur, about 3,100 ft. (no. M 76 A).
Vern. Name: Kotor (Bal.).

Rhamnaceae.

ZIZYPHUS *Juss.*

Zizyphus jujuba *Lam. Dict. III, 318.* Loc.: Near Kochau, 122 miles SSW of Kalat, about 4,100 ft. (no. 211 A) Turbat (Kech), about 600 ft. (no. M 1, M 1A) summit of Burida Pass, 140 miles SSW of Kalat, about 4,250 ft. (no. 211); Nigindap (Kharan), about 50 miles ENE of Panjguri, about 4,000 ft. (no. M 1B). Fl. in. Aug. 1917.—Fr. in Nov. 1917. *Vern. Names*: Ber, Kunar (Bal.), Pissi (Br.).

RHAMNUS *L.*

Rhamnus punctata *Boiss. Diagn. ser. I, II, 4.* Loc.: Rar Kaur. 165 miles S. by W. of Kalat, about 3,500 ft. (no. 152 A).
Vern. Name: Biruri (Br. Bal.).

Rhamnus persica *Boiss. Diagn. ser. I, II, 4.* Loc.: Ornach, 3,080 ft. (no. 318). *Vern. Name*: Jugar (Bal.).

Rhamnus spathulaefolia *F. & M. Ind. Petro. IV, 46.* Loc.: Near Shahdadzai, 72 miles S. of Kalat, 5,100 ft. (no. 151).
Vern. Name: Biruri (Br.).

Sapindaceae.

STOCKSIA *Benth.*

Stocksia brahuica *Benth. in Hook. Kew Journ. V, 304.* Loc.: Sitani, 59 miles S. of Kalat, 5,300 ft. (no. 120). Fl. in Aug. 1917, *Vern. Names*: Kotor (Br.), Zirok (Bal.).

DODONAEA *L.*

Dodonaea viscosa *L. Mant. 233.* Loc.: Hodal Pass (S. side), about 85 miles S. of Panjgur, at 2,400—2,900 ft. (no. M 164 A); Rar Kaur, 165 miles S. by W. of Kalat, about 3,500 ft. (no. 295); Kulbar valley, about 30 miles ENE of Mand, about 1,400 ft. (no. 104). Fl. and fr. in March and April 1918.
Vern. Names: Ghetichk (Bal.), Hamartrik (Br.).

Anacardiaceae.

MANGIFERA *L.*

Mangifera indica *L. Sp. Pl. (1753) 200.* Loc.: Turbat, 63° 4′ E. 25° 58′ N., about 600 ft. (no. M 53). Fl. Feb. 1918.
Vern. Name: Amb (Bal. etc.).
Note: The Turbat mangoes are regarded as very good in Makran.

PISTACIA *L.*

Pistacia Khinjuk *Stocks in Kew Journ. IV. 143.* Loc.: Summit of Burida Pass, between Bhani and Jebri, about 140 miles SSW of Kalat, about 4,250 ft. (no. 210, 210A); Kanoji, 47 miles N. of Las Bela, about 3,200 ft. (210B); Hodal Pass (N. side), about 80 miles S. of Panjgur, 2,800 ft. (M 221), very common on the southern side of the Pass (no. M 222); found from about 2,800 ft. down to about 2,500, where the Pass ends. Fr. in April 1918, in Aug. 1917.
Vern. Names: Kasur, Gwan (Bal. Br.).

Pistacia mutica *F. & M. in Hoh. Talysch Enum. 100.* Loc.: Under Harboi, 16 m ESE from Kalat (no. 46); Gwan berries were

brought in at Bhani, 131 miles SSW of Kalat, but no trees visible in the valley (4,000 ft). The trees are in the hills on either side (no. 202). Fr. in Aug. 1917. *Vern. Name*: Gwan.

RHUS *L.*

Rhus cotinus *L. Sp. Pl. 383.* Loc.: Hushtar Rahi Kaur, on the E. side of the Hushtar Rahi Pass, between Ornach (27° 0′ N, 66° 10′ E.) and Pelar (to West), about 3,700 ft. (no. 310, 301 A). Fr. in Sept. 1917. *Vern. Name*: Kaselo (Bal.).

Leguminosae.

ARGYROLOBIUM *Eckl. & Zeyh.*

Argyrolobium uniflorum *Boiss. Fl. Or. II. 32.* Loc.: Kanoji, 47 miles N. of Las Bela, about 3,200 ft. (no. 391); Manguli, 26° 45. N. 65° 21′ E. about 2,600 ft. (no. M 269A). Fl. in April 1918, Oct. 1917. *Vern. Name*: Kahurkah (Bal.), at Manguli: Kahurbahar.

Argyrolobium Kotschyi *Boiss. Diagn. ser. I. VI, 32.* Loc.: Kalgali Kaur, N. of Zayakh Jangal, about 4,800 ft. (no. M 269C; Kulbar valley, E. of Dagja, 62° 33′ E., 26° 15′ N, about 1,700 ft. (no. M 95A); Junction of Raghaiad and Gichk rivers, about 3,600 ft. (no. M 95D); Kulbar valley, about 25 miles ENE of Mand, about 1,300 ft. (no. M 106); Hills near Ispikan, about 20 miles NE of Mand, about 1,200 ft. (no. M 95); Rodkan (W. Kolwa) about 85 miles E. of Turbat, about 1,800 ft. (M 95B); Nag (W. Kolwa) about 83 miles N. of Turbat, about 2,300 ft. (no. M 239); Rar Kaur, 165 miles S. by W. of Kalat, about 3,500 ft. (no. 299). Fl. and fr. in March and April 1918, in Sept. 1917.
Vern. Name: Cheink (Bal.). Seems to be a sort of generic name.

Argyrolobium *sp.* Loc.: Rari Dan, 170 miles S. by W. of Kalat, 2,300 ft. (no. 291); Siman river, 15 miles SE. of Khozdar, about 3,700 ft. (no. 360). Fl. in Sept. 1917. *Vern. Name*: Chevid (Br.).

ONONIS *L.*

Ononis sp. Loc.: Benn Chah, 21 miles N. of Surah, about 6,200 ft. (no. M 386).

TRIGONELLA *L.*

Trigonella near **uncata** *Boiss. & Noe Diagn. ser. II, II, 12.* Loc.: Sarchib, about 62° 40′ E, 26° 16′ N. about 1,900 ft. (no. M 117); Mohtaji Kand, about 22 miles SW. of Panjgur, about 2,800 ft. (no. M 117B); Panjgur, about 3,100 ft. (no. M 117C.). Fl. in March 1918. *Vern. Name*: Shims (Bal.), Goki Shimsh (Bal.).

MEDICAGO *L.*

Medicago tribuloides *Desr. in Lam. Encycl. III. 635.* Loc.: Sarchib (no. M 117A); Chib 63° 8′ E. 26° 19′ N. about 1,600 ft. (no. M 117); Wahir, 25 miles W. of Khozdar, about 4,200 ft. (no. 331A). Fl. and fr. in March 1918, Oct. 1917. *Vern. Name*: Shimsh, Goki Shimsh (Bal.), Marav, Merav (Br.). Note: Our specimens have strongly emarginate mucronate leaflets, dentate at the tip. Boissier does not mention this.

Medicago denticulata *Willd. Sp. III, 1414.* var. **lappacea** *Boiss. Fl. Or. II. 103.* Loc.: Panjguri, about 3,100 ft. (no. M 117D). Fl. and fr. in March 1918.
Vern. Names: Goki Shims (Bal.), Mena (Sind.).

Medicago sativa *L.*—Lucerne. Loc.: Quetta. Fl. in August.

Medicago sp. near **praecox** *DC. Cat. Monsp. 123.* Loc.: Hazarganji, 27° 28′ N, 66° 12′ E, about 3,600 ft. (no. 331). Fl. in Sept. 1917. *Vern. Names*: Shims (Bal.), Marav (Br.).

Madicago sp. Loc: Nagak (W. Kolwa), near mouth of Hodal Pass, about 87 miles E. by N. of Turbat, about 2,400 ft. (no. M 117E). Fl. in April 1918. *Vern. Name*: Goki Shims (Bal.).

Medicago sp. near **coronata** *Lam. Dict. III, 634.* Loc.: Hazarganji, 27° 28′ N, 66° 12′ E., about 3,600 ft. (no. 332). Growing in a partially flooded meadow. Fl. and fr. in Sept. 1917.
Vern. Name: Shims (Bal.).

MELILOTUS *Turnef.*

Melilotus alba *Desr. in Lam. Dict. I, 63.* Loc.: Panjguri (M 338, M 338A). Fl. in June 1918. *Vern. Names*: Shams (Bal.), Jangli Meni (? Sind.). Uses: Leaves eaten as a vegetable.

Melilotus indica *All. Fl. Pedem. I (1785) 308.* Loc.: Panjguri, about 3,100 ft. (no. M 158, M 145), Nagak (W. Kolwa) about 87 miles E. by N. of Turbat, about 2,400 ft. (no. M. 158A). Fl. and fr. in March and April 1918. Uses: This plant is eaten by man, cooked as a vegetable. *Vern. Names*: Mardumi Shims (Bal.). Madi Shims.

TRIFOLIUM *L.*

Trifolium fragiferum *L. Sp. Pl. 1086.* Loc.: Kalat, about 6,350 ft., plentiful on the edges of irrigated lands (no. M 307A); Iskalku, 7 miles E. of Kalat, 7,500 ft., grows on edges of irrigation channels (no. 10, 10 C); Surab, 43 miles S. of Kalat, 5,750 ft. (no. 103, M 370), grows by water with clover. Fl. in June 1918, Aug. 1917. *Vern. Name*: Jaghar Kirm (Br.), this name comes from the idea that if sheep eat it they get worms in the liver. Horses suffer no harm.

DORYCNIUM *Tourn.*

Dorycnium villosum *Blatt. and Hall. spec. nov.* Herba perennis, villoso-hirsuta, a basi lignosa et ramosa; caules ascendentes, sulcati, foliosi, internodiis brevibus. Folia subsessilia. Petiolus simul cum rhachide 3 mm longus, fortis, sulcatus. Foliola 4, quorum unum terminale, duo terminali proxima et unum in parte inferiore. Petioluli breves sed distincti, graciles. Foliola spathulato-cuneata, mucronata, 10 mm longa, 3 mm lata in parte latissima, parce hirsuta vel glabrescentia in facie superiore, densissime villoso-hirsuta in facie inferiore. Pedunculi erecti, foliis aequilongi, umbellatim 2-3-flori, bractea unica dimidiam partem folioli attingente. Pedicelli 1-2 mm longi. Calyx subaequaliter 5-fidus, dense hirsutus, lobis subulatis, tubo aequilongis in flore, elongatis in fructu. Corolla parum exserta, flava; vexillum apice rubrum? longius caeteris petalis; carina acuta (sed non

rostrata). Legumen 13 mm attingens, cylindricum, turgidum, apice breviter cuspidatum, divisum septulis transversis, glabrum, suturis prominentibus, valvis rugosis. Semina orbiculata, parum compressa, glabra, atro-olivacea. Nota: Species Dorycnii hucusque observatae habent carinam obtusam, nostra autem acutam. Haec differentia non est ratio sufficiens cur nova species excludatur a genere Dorycnii. Nullo modo potest includi sub genere Loti, cum carina careat rostro. Loc.: Hills near Ispikan, about 20 miles NE of Mand, about 1,200—1500 ft. (no. M 89, M 89 A). Fl. and fr. in March 1918.
Vern. Name: Meshkah (Bal.).

LOTUS *L.*

Lotus tenuifolius *Reichb. Fl. exc. 506.* Loc.: Surab, 28° 29′ N. 66° 16′ E., about 5,700 ft. (no. 105, M 369). Fl. in June 1918, Aug. 1917.—Fr. in Aug. 1917. Note: The flowers range from pure yellow through orange to bright red.

CYAMOPSIS *DC.*

Cyamopsis psoralioides *DC. Prodr. II, 216.* Loc.: Nal, 27° 41′ N, 66° 13′ E. 3,834 ft., probably self sown from some garden (no. 336); Gaz, 18 miles N. of Ornach, about 3,500 ft. (no. 323). Fr. in Sep. 1917. *Vern. Name*: Metli (Br.).

INDIGOFERA *L.*

Indigofera paucifolia *Del. Fl. D'Eg. (1812) 251.* Loc.: Rodkan (W. Kolwa), about 85 miles E. of Turbat, about 1,800 ft.; Zahren Kahur, 16 miles N. of Pasni, about 200 ft. (no. M42, M42A).
Vern. Names: Lantu, Timer (Bal.), Hudish (Br.).

Indigofera paucifolioides *Blatt. & Hall. spec. nov.* Suffrutex gracilis, argenteo-canescens in omnibus partibus floribus exceptis, ramis gracilibus. Internodia ca. 3 cm longa. Folia pinnatim 3-foliolata, stipulis annulum scariosum formantibus circumcingentem ramum. Petiolus circa 6 mm longus, rhachis 2-3 mm, persistens, quasi spinescens. Foliola elliptica vel elliptico-lanceolata, subacuta, alterna, terminale longissimum. Racemi axillares, 5-6 cm longi, 5-10-flori, laxi, bracteis minutissimis, pedicellis 1½ mm longis, fortibus, patentibus. Flores 13 mm attingentes. Calyx tubulosus, 7 mm longus, dense adpresse hirsutus, oblique 5-dentatus, dentibus subulatis subaequalibus in parte anteriore, sinu profundo rotundato in parte dorsali. Corolla multum exserta; carina necnon alae vexillo breviores. Legumen non vidimus. Differt ab Indigofera paucifolia floribus minus numerosis sed multo longioribus, forma stipularum. Loc.: Wad, 27° 20′ N., 66° 20′ E., about 4,000 ft. (no. 226 B). Fl. in Oct. 1917.

Indigofera Houer *Forsk. Fl. Aegypt.-Arab. (1775) 137.* Loc.: Near Sorki Chah, Pirandar, about 205 miles SSW of Kalat, about 1,900 ft. (no. 254). Fl. and fr. in Sept. 1917. *Vern. Name*: Niltako (Bal.).

TEPHROSIA *Pers.*

Tephrosia purpurea *Pers. Syn. Pl. II (1807) 329.* Loc.: Pirandar, 205 miles SSW of Kalat, about 1,900 ft. (no. 263); Sor (Kilkaur), about 74 miles S. of Panjgur, about 2,300 ft. (no. M 9G); Dokop,

60 miles W. of Turbat, about 700 ft. (no. M9); Pump, 46 miles W. of Turbat, about 600 ft. (no. M63); 5 miles N. of Mand, about 1,000 ft. (no. M 9E); Ispikan, 16 miles NE. of Mand, about 1,050 ft. (no. M 9F); Awaran, (Kolwa), 26° 24′ N., 65° 12′ E. about 1,750 ft. (no. M 9H). Fl. and fr. in March 1918, Sept. 1918, Dec. 1917. *Vern. Names*: Matkinaok (Bal.), Sanamaki (Kechi Bal.). Note: The flowers show a great range of colour, the most common being a sweet-pea pink with a tinge of blue, but others are very bright chrome red; white seems to be very uncommon. This species is very variable, so much so that we cannot retain Baker's varieties in Hook. f. Fl. Brit. Ind. II, 113.—It is for the same reason that we combine Tephrosia Apollinea Link. Enum. Hort. Berol. II (1822) 252, with Tephrosia purpurea Pers. There is not one character in the diagnosis of T. Apollinea which may not be observed in some specimen of T. purpurea.

Tephrosia *sp.* Loc.: Dokop, 10½ miles E. of Mand, about 650 ft. (no. M 69); Kulbar valley, some 25 miles ENE of Mand, about 1,300 ft. (no. M 107).

CALOPHACA *Fisch.*

Calophaca tomentosa *Blatt. & Hall. spec. nov.* Herba perennis, villoso-tomentosa, caule subsimplici, tereti, 6 cm alto, folioso a basi, internodiis ca 10 mm longis. Folia 9 cm attingentia, stipulis triangulari-oblongis, integris vel profunde bifidis, cum petiolo connatis, 5 mm longis, petiolo 20-25 mm longo; foliola 11-19, oblonga, obtusa vel retusa, basi rotundata et parum obliqua, 15 mm longa, 6 mm lata, in parte superiore saepe latiora. Pedunculi axillares, 5-8 mm longi, fortes, umbellatim 1-2 flori, bracteis minutis, setaceis, hirsutis. Pedicelli ca 5 mm longi, bracteolis duobus circa medium. Calyx tubulosus, 12 mm longus, inaequaliter 5-dentatus, sublabiatus, dentibus superioribus altius connatis, dente infimo brevissimo, in fructu fissus. Petala 15 mm longa, longitudine subaequalia; carina ad apicem valde rotundata, ampliata et repente incurvata. Stamina diadelphia. Stylus apice incurvus, glaber, stigmate terminali capitato. Legumen immaturum 4 cm latum, lineari-compressum, dense villoso-tomentosum, rostro recurvo. Loc.: Pahrechi Kaur, 10 miles N. of Ornach, about 3,630 ft. (no. 322). Fl. and fr. in Sept. 1917.

Calophaca parviflora *Boiss. Fl. Or. II, 201.* (Chesneya parviflora *J. & Sp.*) Loc.: Mitasing, about 17 miles ESE of Panjguri, about 4,000 ft. (no. M 319); Panjguri, about 3,100 ft. (no. M 319 A). Fl. in May 1918. *Vern. Name*: Mesho (Bal.).

CARAGANA *Lam.*

Caragana ulicina *Stocks in Hook. Journ. IV. 145.* Loc.: Hushtar Rahi Kaur, about 160 miles S. of Kalat, up to about 4,000 ft. (no. 37 B); very common on both sides of the pass. Fl. in Sept. 1917. *Vern. Names*: Siahchob (Bal.), Hajipit (Br.).

Caragana ambigua *Stocks in Hook. Journ. IV. 145.* Loc.: Harboi, 18 miles ESE of Kalat, 9,000 ft. (no. 19; Benncah, 21 miles N. of Surab, about 6,200 ft. (no. M 386). *Vern. Name*: Sipit (Br.),

Chidirk, "which is properly the name of the babul, which is not found up here (Harboi)." Uses: It is good for firewood and goats eat it.

Caragana sp. Loc.: Rar Kaur, 165 miles S. by W. of Kalat, up to about 4,000 ft. (no. 37A).
Vern. Names: Siahchob (Bal.), Hajipit (Br.).

GLYCYRRHIZA *L.*

Glycyrrhiza glabra *L. Sp. Pl. 1048* var. **glandulifera** *Reg. & Herd.* Loc.: Pusht Kuh (Kharan), about 26° 57′ N, 65° 10′ E, about 3,500 ft. (no. M 300, M. 300 A). Uses: The root is said to be good for sore throats. When chewed it has a not unpleasant rather sweet flavour, somewhat like that of an uncooked green pea. It is also mixed with other drugs for derangements of the blood. (Hotson).
Vern. Name: Washdar (Bal.).

ASTRAGALUS *L.*

Astragalus tribuloides *Del. Ill. Eg. 22.* Loc.: Manguli, 26° 45′ N, 65° 21′ E, about 2,600 ft. (M. 269 B); near Kuldan, about 85 miles E. by N. of Turbat, about 2,400 ft. (no. M 233). Fl. and fr. in April 1918. *Vern. Name*: Kahurkah (Bal.).

Astragalus Stocksii *Benth. in Herb. Kew et Bunge Astr. 5.* Loc.; Junction of Raghni and Sichk rivers (Kharan), about 3,600 ft. (no. M 122A): Mantar Juzhaf, about 40 miles S. of Panjgur, about 3,200 ft. (no. M 202); Gili, about 10 miles W. of Chib, about 1,650 ft. (no. M 122); near Shahdadzai, 42 miles S of Kalat, 5,100 ft. (no. 132 A): near Sitani, 59 miles S. of Kalat, 5,300 ft. (no. 132). Fl. in April 1918, Aug. 1917. Uses: A very good camel-grazing bush. *Vern. Names*: Shinilok (Bal., Br.), Shinilo, Shinalok (Bal.), Shenelo (Br.).

Astragalus polemius *Boiss. Fl. Or. II, 306.* Loc.: Near Ornach, about 3,300 ft. (no. 311); Siman river, 15 miles SW. of Khozdar, about 3,700 ft. (no. 311A). *Vern. Name*: Bakhmal (Br.).

Astragalus strobiliferus *Royle Ill. 199.* Loc.: Harboi, 18 miles ESE of Kalat, 9,000 ft. (no. 32). Grows in thick close spiny clusters, a few inches high. Uses: Eaten by sheep. *Vern. Name*: Pith (Br.).

Astragalus sp. Loc.: Harboi, 18 miles ESE of Kalat, 9,000 ft. (no. 39.) Grows in thick masses a few inches high. Uses: Eaten by sheep, camels, etc. *Vern. Name*: Gird Pith (Br.).

Astragalus sp. Loc.: Harbud, about 55 miles E. of Panjgur, 3,700 ft. (no. M 269 C). Fl. in April 1918.
Vern. Names: Kahurbahar (Bal.), Kandiko (Br.).

TAVERNIERA *DC.*

Taverniera nummularia *DC. Mem. Leg. 339, tab. 52.* Loc.: Korak (Pelar), 180 miles S. by W. of Kalat, 1,900 ft. (no. 226 A); Turbat, about 600 ft. (no. M 4); N. E. of Hoshap, about 60 miles ENE of Turbat, about 2,000 ft. (no. M 35); Garrok, 32 miles N. of Pasni, about 350 ft. (no. M 4 B); below Gajar, 165 miles SSW of Kalat, about 3,450 ft. (no. 226); Hodal Pass (S. side) about 85 miles S. of Panjgur, 2,900-2,400 ft. (no. M 4 C). Fl. in Feb. 1918, Sept. 1917. *Vern. Names*: Hudish, Lantu (Bal., Br.).

Taverniera Stocksii *Boiss. Fl. Or. II, 509.* Loc.: Kaurdat, 10 miles N. of Rekin, about 1,900 ft. (no. M 4 D); Pirandar, about 205 miles SSW of Kalat, about 1,900 ft. (no. 252); Korak (Pelar), 180 miles S. by W. of Kalat, 1,900 ft. (no. 271). Fl. in Sep. 1917. *Vern. Name*: Siahbar (Br.).

Taverniera glabra *Boiss. Diagn. ser. I, II, 90.* Loc.: Ispikan, 16 miles NE of Mand, about 1,050 ft. (no. M 75); Gajar 165 miles SSW of Kalat, 3,450 ft. (no. 227); hills S. of Chambar (Kolwa), 26° 9′ N, 64° 42′ E. 1,800—2,200 ft. (no. M 75 A). Fl. in March and April 1918, Sept. 1917. *Vern. Names*: Latug, Lantu (Bal.).

Taverniera sp. Loc.: Ispikan, 16 miles NE of Mand, about 1,050 ft. (no. M 80); Karki 21 miles ENE of Buleda, about 1,600 ft. (M 128); Gwambuk, about 60 miles S. by E. of Panjgur, about 2,700 ft. (no. M 211).

EBENUS *L.*

Ebenus erinacea *Jaub. and Sp. Ill. Or. tab. 255.* Loc.: Hills near Ispikan, about 20 miles N. of Mand, about 1,200—1,500 ft. (no. M 96). *Vern. Name*: Sag-I-Dantal (Bal.). Note: We have separated Ebenus erinacea from E. stellata Boiss. Jaubert and Spach's illustrations bring out the differences between the two species sufficiently.

ALHAGI *Desv.*

Alhagi camelorum *Boiss. Diagn. ser. I, IX, 114.* Loc.: Panjgur (no. M 62 C); Tump, 46 miles W. of Turbat, about 600 ft., very common all over the country (no. M 62); Mohtaji Kand, about 22 miles SW. of Panjgur, about 2,800 ft. (no. M 62 A); Sitani, 59 miles S. of Kalat, 5,300 ft. (no. 121); Quetta; Mazarjuh, about 28° 11′ N, 66° 2′ E., about 5,200 ft. (no. M 62 D). Fl. in May and June 1918.—Fr. in June and Aug. 1918. *Vern. Names*: Shinz (Bal., Br.).

VICIA *L.*

Vicia angustifolia *Roth Tent. I, 310.* Loc.: Panjgur (no. M 147 A). Fl. and fr. in March 1918.
Vern. Names: Mashuk (Bal.), Mashuka (Sind.).

VIGNA *Savi.*

Vigna catiang *Walp. in Linnaea XIII (1839) 533.* Loc.; Lukh, 100 miles S. of Kalat, 4,300 ft. (no. 178.). Fl. in Aug, 1917.

RHYNCHOSIA *Lour.*

Rhynchosia minima *DC. Prodr. II, 385.* Loc.: 3,500 ft. downwards, exact locality not given (no. 393 B). Fl. and fr. in Oct. 1917. *Vern. Name*: Wal.

Rhynchosia minima *DC.* var. **laxiflora** *Baker in Hook. f. Fl. Brit. Ind. II.* 223. Loc.: Near Ornach, about 3,000 ft. (no. 320). Fl. and fr. in Sept. 1917. *Vern. Name*: Shanmazar.

DALBERGIA *L. f.*

Dalbergia sissoo *Roxb. Hort. Beng. 53.* Loc.: Zidi, 15 miles ESE of Khozdar, about 3,600 ft. (no. 294 A).
Vern. Names: Jag (Bal. Br.), Tali (Sindhi).

Dalbergia latifolia *Roxb. Cor. Pl. II, 7, t.* 113. Loc.: Rar Kaur, 165 miles S. by W. of Kalat, about 3,500 ft. (no. 294.)
Vern. Names: Jak (Bal.), Jag (Br.Bal.).

SOPHORA *L*

Sophora Griffithi *Stocks in Hook. Journ. IV (1852) 147.* Loc.: Hills about 35 miles SW. of Panjgur, about 2,800 ft. (no. M 130); hills S. of Chambar (Kolwa), 26° 9′ N., 64° 42′ E. about 2,160 ft. (no. M 255); Pusht Kuh, about 26° 57′ N., 65° 12′ E. about 3,500 ft. (no. M 130 B). Teghab., 107 miles S. of Kalat, 4,150 ft. (no. 16A); Harboi, 18 miles ESE of Kalat, 9,000 ft (no. 16): sandy ground and the edges of dry sandy river beds at Siahen Camb, about 36 miles E. by S. of Panjgur, about 3,800 ft. (no. M130C). Fl. in March 1918, Aug. 1917.—Fr. in April 1918. *Vern. Names*: Shampashtir (Br., Bal.), Shampashtig (Kechi Aal.), Shampachir (Panjguri Bal.), Shamkastir.

Sophora alopecuroides *L. Sp. PI. 373.* Loc.: Kalat, between 6,350—7,000 ft. (no. 92, M 39 A). Fl. and fr. in July 1918. Uses: Used as a green manure for melons, being buried under the young plants. *Vern. Name*: Basunduk (Br.).

PARKINSONIA *L.*

Parkinsonia aculeata *L.* Loc.: Gajar, 165 miles SSW of Kalat, 3,450 ft. (no. 233), growing in a garden.
Vern. Name: Vilayati Babar (Bal.),

CASSIA *L.*

Cassia obovata *Collad. Mon. 92.* Loc.: Pirandar, about 205 miles SSW of Kalat, about 1,900 ft. Fl. and fr. in Sept. 1917.

PROSOPIS *L.*

Prosopis spicigera *L. Mant. 68.* Loc.: Near Bazdad, 25 miles E. of Chambar, Kolwa, about 1,850 ft. (no. M 279); below Bhani, 131 miles SSW of Kalat, about 3,800 ft. (no. 209). Very common. *Vern. Names*: Kahur (Bal.), Mar (Br.), Kandi (Sind), Kikar (Urdu).

ACACIA *Willd.*

Acacia arabica *Willd. Sp. Pl. IV (1805) 1085.* Loc.: Andrabedi river, about 42 miles N. of Las Bela, about 3,500 ft. *Vern. Names*: Chidirg (Bal. Br.), Chidrik (Br.), Hari Babar (Sind.)

Acacia Jacquemontii *Benth. in Hook. Lond. Journ. I (1842) 499.* Loc.: Nasirabad, 23 miles W. of Turbat, about 400 ft. (no. M 57). Fl. in March 1918. *Vern. Name*: Chigird Chidirg (Bal.).

Acacia Senegal *Willd. Sp. Pl. IV (1805) 1077.* Loc.: Near Kanoji, 47 miles N. of Las Bela, about 3,200 ft. (no. 377).
Vern. Name: Khor (Br.).

ALBIZZIA *Durazz.*

Albizzia Lebbek *Benth. in Hook. Lond. Journ. Bot. III (1844) 87.* Loc.: Basunkani springs, about 38 miles N. of Las Bela, about 2,900 ft. (no. 394). This tree becomes common as one goes S. from here. Many trees at Las Bela. *Vern. Name*: Siri (Br.).

Rosaceae

PRUNUS *L.*

Prunus brahuica *Aitch. and Hemsl. in Trans. Linn. Soc. ser. 2, Bot. III, 62.* Loc.: Near Sitani, 59 miles S of Kalat, 5,300 ft. (no. 130).

Prunus oburnea *Aitch. and Hemsl. in Trans. Linn. Soc. ser. 2, Bot. III, 62.* Loc.: Dokop, 60 miles W of Turbat, about 700 ft. (no. M 15); Kaur Dat, 10 miles N of Rekin, about 1,900 ft. (M 15C); Harboi, 18 miles ESE of Kalat, 9,000 ft. (no. 20). Uses: Men, animals and birds eat the fruit.
Vern. Names: Jogar (Bal., Br.), Mozhmonk (Br.).

Prunus *sp.* Loc.: Harboi, 18 miles ESE of Kalat, 9,000 ft. (no. 37). *Vern. Name*: Siahchob.

PYRUS *L.*

Pyrus cordata *Desv. Obs. Pl. Anj. 152.* Loc.: Panjgur, about 3,100 ft. (no. M 153). Fl. in March, 1918.

ROSA *L.*

Rosa anserinaefolia *Boiss. Diagn. ser. I, VI, 51.* Loc.: Harboi, 18 miles ESE of Kalat, 9,000 ft. (no. 15). Fl. in August, 1917. *Vern. Name*: Atishi Gulab.

Onagraceae

EPILOBIUM *L.*

Epilobium hirsutum *L. Sp. Pl. 494.* Loc.: Khozdar, 27° 48′ N, 66° 37′ E, about 4,100 ft., near irrigation channels (no. 343). Fl. and fr. in September, 1917. *Vern. Name*: Sorphul (Bal., Br.).

Epilobium parviflorum *Schreb. Spic. 146.* Loc.: Zidi, 15 miles ESE of Khozdar, about 3,600 ft. (no. 343A). Fl. in September, 1917. *Vern. Name*: Sorphul (Bal.).

Epilobium minutiflorum *Hausskn. in Oestr. Bot. Zeitschr. XXIX (1879) 55.* Loc.: Harboi springs, 18 miles ESE of Kalat, 8,600 ft. (no. 67). Fl. and fr. in August, 1917. Uses: The seeds are soaked to make a sharbot, which is drunk both for pleasure and to cure head aches. *Vern. Name*: Rush (Br.).

Cucurbitaceae

CUCUMIS *L.*

Cucumis trigonus *Roxb. Hort. Beng. (1814) 70.* Loc. W. side of Burida Pass, 140 miles SSW of Kalat, under 4,250 ft. (no. 216); near Sorki Chah, Pirandar (no. 273). Fl. in August, 1917.
Vern. Name: Wal (Br., Bal.).

Cucumis melo L. *Sp. Pl. (1753) 1011*, var. *agrestis* Naud. in Ann. Sci. Nat. ser. 4, XI (1859) 73 and XII, 110. Loc. Las Bela, about 700 ft. (no. 324A); Jebri, 247 miles SSW of Kalat, 3,850 ft. (no. 225); Garruk, 27 miles N of Ornach, about 3,400 ft. (no. 324); Korak (Pelar), 180 miles S by W of Kalat, 1,900 ft. (no. 267). Fl. in August,

September and October, 1917. *Vern. Names*: Chibit (Br.), Chibid (Sindhi), Wal (Bal. Br.), Girat Wal (Br.).

Cucumis prophetarum L. *Cent. Amoen. Acad. IV* (*1759*) *295*. Loc.: Pirumar, 16 miles S of Khozdar, about 4,100 ft. (no. 364). Fr. in September, 1917. Uses: The fruit is said to cause instant vomiting, and to be used medicinally for that purpose. *Vern. Name*; Het Chibit.

CITRULLUS *Neck.*

Citrullus colocynthis *Schrad. in Linnaea XII* (*1838*) *414*.

Loc.: Near Manguli, 197 miles SSW of Kalat, about 2,450 ft. (no. 243); Teghab, 107 miles S of Kalat, 4,150 ft. (no. 186); Chhuttok, 90 miles S of Kalat, 4,500 ft. (no. 173); Rek. Chah, 11 miles E of Chambar (Kolwa, about 1,800 ft. (no. M 267). Fl. in August and September, 1917.—Fr. in August, 1917.
Vern. Names: Hinjiri (Bal.), Kiringli (Br.), Kulkushtag (Bal.); Tarbuzah-abu-Jir Hagara, Persian, Gunj (Kechi Bal.).

COCCINIA *W. & A.*

Coccinia indica *W. and A. Prodr.* (*1834*) *347*. Loc.: Korak (Pelar), 180 miles S by W of Kalat, 1,900 ft. (no. 275); Audrabedi river, 42 miles N of Las Bela, Diria Gadha 35 miles N of Las Bela, 3,500—2,500 ft. (no. 393). Fl. and fr. in September, 1917.
Vern. Name: Wal. (Bal., Br.).

MELOTHRIA *L.*

Melothria maderaspatana *Cogn. in DC. Monogr. Phan. III* (*1881*) *623*. Loc.: Pirandar, 205 miles SSW of Kalat, about 1,900 ft. (no. 258). *Vern. Name*: Wal (Bal., Br.).

CORALLOCARPUS *Welw.*

Corallocarpus epigaeus *C.B. Clarke in Hook. f. Fl. Brit. Ind. II*, *628*. Loc.: Der river, 38 miles N of Las Bela (no. 393 F). Fr. in October, 1917. *Vern. Name*: Wal (Bal., Br.).

Ficoideae.

TRIANTHEMA *L.*

Trianthema monogyna *L. Mant.* 69 Loc.; Rek Chah, 11 miles E of Chambar, Kolwa, about 1,800 ft. (no. M 270); Goshamag, about 16 miles E of Chambar, Kolwa, about 1,850 ft. (no. M272); Jebri, 137 miles SSW of Kalat, 3,775 ft. (no. 117A). Fl. and fr. in April, 1918, August, 1917. *Vern. Names*: Lipchanko, Uwalu (Bal.), Surinchk (Br.).

Trianthema pentandra *L. Mant. 79.* Loco.: Tharrav, about 32 miles S of Wad, about 3,800 ft. (no. 382); Kurak (Pelar), 180 miles S by W of Kalat, 1,900 ft. (no. 278); Zid, 15 miles ESE of Khozdak. about 3,600 ft. (no. 354). Fl. and fr. in September and October 1917. *Vern. Name*: Khisun Vel (Br.).

ORYGIA *Forsk.*

Orygia decumbens *Forsk. Fl. Aegypt.-Arab. 103.* Loc.: Kanoji, 47 miles N of Las Bela, about 3,900 ft. (no. 384). Fl. and fr. in October, 1917.

(*To be continued.*)

CURRENT LITERATURE.

Histology.

Harper, R. A. The structure of protoplasm. *Am. Jour. Bot. 6 (1919) pp. 273—300.*

A quarter of a century ago there was much speculation regarding the physical structure of protoplasm. It was then expected that better fixation, better staining processes, and more accurate microscopic observation would reveal this structure. Since then there has been much evidence accumulated bearing on the problem, though there has been little attempt to formulate rigid theories of the structure of protoplasm.

Professor Harper of Columbia University, in an address before the Botanical Society of America in 1917, has brought to bear on the problem what he considers to be the most important evidence from recent work in cytology, in the chemistry of the colloidal state, and in genetics. He points out that evolution has been along the lines of specialization of cells groups and division of labour between cells, rather than by any change in fundamental cell organization.

He considers that the most significant evidence from cytology is the recognition of differentiated areas within the protoplasm, within which specific processes are carried on. Examples are elaioplasts or fat-forming bodies, plastids of various kinds, vacuoles, and chromosomes. In many of the lower plants the chloroplasts appear not to have a definite limiting membrane like a plasma membrane, but are more or less vaguely restricted regions of the protoplasm impregnated with chlorophyll. With increasing localization of position and specialization in function, these protoplasmic areas finally become permanent and self-perpetuating. Chromosomes, for instance, always arise from pre-existing chromosomes by an astonishingly complicated and precise division. He believes that "the bulk of the literature of the plant chondriosome is a mere tabulation of the appearance of variously fixed and colored particles in the cell body with the hope that such bodies may later be found to be specific and fundamentally significant." The concept of localized areas of protoplasm for specific function would include all the organs of the cell, temporary as well as permanent.

Perhaps the most important evidence from recent chemistry of the colloidal condition is the "recognition of the fact that the units of colloidal systems, especially those of proteins, carbohydrates, etc., are large enough to be distinguishable at least with our present microscopes". Protoplasm is a colloidal substance, often thought of as a simple two-phase system with water or some other non-living substance as one of the phases. BUTSCHLI considered it to have an alveolar structure, with the living substance forming the continuous walls and the non-living occupying the vacuoles; BEIJERINCK and others conceived of protoplasm as made up of granules of living substance distributed through a non-living matrix. Interpreted in terms of a colloidal solution the first theory would make the continuous phase the more important, while the second would make the disperse phase the more

important. Doubtless protoplasm may change from one condition to the other in response to changing conditions.

But protoplasm certainly is not so simple as a simple two-phase colloidal system. The present theory of colloids allows for the possibility of one colloidal system containing other more or less differentiated systems. "The cell must at least be conceived as a complex of such colloidal systems, some possibly simple two-phase systems . . . some polyphase . . ." Such a conception would account for the presence of localized areas in which special processes are carried on. The surface tension membranes between the various constituents would hinder diffusion between the different regions of the cell, would make possible the maintainance of the various structures and organs of the cell which the microscope reveals, and would permit widely diverse processes to go on simultaneously within the same cell.

Genetics and the structure of protoplasm. Some sort of serial arrangement of hereditary factors in the chromosomes theoretically appears best to fit the facts of chromosome reduction and segregation of factors. From a few accurate records of size and volume of chromosomes, and from measurements that have been made of the size of various molecules, there appears to be plenty of room in chromosomes for a number of molecules "equal to the most extreme demands of the factorial hypothesis, if each factor can be represented by a single molecule or even a group of molecules."

WINFIELD DUDGEON.

Mottier, David M. Chondriosomes and the primordia of chloroplasts and leucoplasts. *Annals of Botany XXXII (1918) pp. 91-114. 1 pl.*

Chondriosomes (mitochondria) were discovered in plant cells by Meves in 1904. Since then a great deal of research has led to the conclusion that they are very numerous in the cytoplasm; that they are practically universally present in plant cells; and that they are almost certainly permanent cell organs, being transmitted from one cell generation to the next along with the cytoplasm. Some have claimed that they become transformed into plastids of various kinds, while others hold that chondriosomes and the bodies which develope into plastids are quite distinct. It has been found that some of the most commonly used killing and fixing reagents, especially acetic acid, destroy chondriosomes, and this fact probably accounts for their late discovery.

Mottier used as a fixing solution

1% chromic acid	17 cc.
2% osmic acid	3 cc.
glacial acetic acid	3 drops

and stained with either a modification of Benda's crystal violet method or iron-alum-haematoxylin. He worked with root tips of *Pisum sativum*, *Zea mays*, and *Adiantum pedatum;* thalli of *Marchantia polymorpha*, *Anthoceros laevia*, and *Pallavicinia;* seedlings of *Pinus Banksiana;* and stem and leaves of *Elodea canadensis*. *Pisum* proved to be the most satisfactory material for study.

When properly fixed and stained, the meristem cells of the root-tip of *Pisum* show a large number of small but quite conspicuous bodies of two distinct kinds scattered through the cytoplasm: some are larger, straight or variously bent rods of varying length and thickness; others are very small granules occurring singly or in chains, or delicate slender

straight or curved rods, also of varying length and thickness. Both kinds multiply by transverse division. Passing from the meristem to the older cells of the root, some of the larger rods begin to grow, and enlarge at one or more points, and finally become plastids with starch grains in the enlargements; those that do not become plastids at length disorganize. The minute rods and granules persist practically without change in size, form, and number as the cells grow older. He calls the larger rods "primordia of plastids", and restricts the term chondriosomes to the minute bodies.

Zea mays, *Adiantum*, *Pinus* seeding, and *Elodea* gave similar results. In *Marchantia* both plastids and their primordia are present in all vegetative cells, but chloroplasts are early eliminated from spermatogenous tissues and only the chondriosomes remain. It has been suggested that chondriosomes are the remains of disintegrated plastids. *Anthoceros* furnishes valuable evidence on this point, since each cell contains but one chloroplast. The author finds chondriosomes present in large numbers in all cells; they are just as numerous in cells with healthy normal chloroplasts as in those in which the chloroplasts appear abnormal. This disposes of the plastid origin of chondriosomes.

The conclusion is that chondriosomes and the primordia of plastids are quite distinct, and are fairly easily distinguished by their difference in size, even though they show the same staining reactions. Much of the confusion in earlier writings has been due to failure to recognize this fact. He thinks "We are now justified in the view that leucoplasts, chloroplasts, and chondriosomes are organs of the cells, of the same rank as the nucleus", and that if this be true, "these bodies must be transmitted from individual to individual in the form of their primordia, and that chromatin is not the sole carrier of hereditary characteristics". "To claim that certain phenomena of fluctuating variability and other numerous characteristics, Mendelian or otherwise, owe their appearance and transmission to the primordia of plastids and chondriosomes may be a daring hypothesis, but, if as there is good reason to believe, these bodies are permanent organs, there is no escape from some such assumption.

The reader is left with the feeling that the work has been carefully and thoroughly done, and that the conclusions are convincing.

W. D.

Some New Laboratory Methods.

Gussow, H. T. A new method for "hanging drop" cultures. *Phytopathology 8; (1918) p. 447.*

Instead of the usual drop suspended from the under side of a coverglass, the author recommends that the drop be flattened out into a thin film by means of a smaller coverglass placed over it. This keeps the culture in a thin layer, and permits examination of all parts with the highest powers of the microscope.

Bachman, Freda M. A bacteriological method useful for the study of other microorganisms. *Am. Jour. Bot. 5 1918 pp. 32-35.*

Ordinary methods of the culture of bacteria are adapted so that the cultures may be grown on microscopic slides and made into permanent preparations. Bacteria when grown on a slide in a thin film of hard nutrient medium retain their normal position in the colony. The method has been

found valuable for the study of yeasts. Hard potato agar (potato broth with 3 % agar and 2 % dextrose) is carefully cleared and stored in test tubes. When wanted for use, the agar is barely melted, and inoculated with a thick culture of yeast. A small drop of the suspension is spread evenly over a chemically clean warm slide, then incubated in a damp chamber at favourable temperature. When the colonies of yeast have reached the desired stage of development, they are killed and stained by any of the standard methods. Great care must be exercised to prevent the agar film from floating off the slide. In practice it is better to leave one end out of the solutions so that the agar film may become dry. After staining, the film is dehydrated, cleared, and mounted in the usual manner. The great advantage is that the cells of the colony are retained in their normal position, and are all in one plane

Goodspeed, T. H. Method of replacing paraffin solvent with paraffin. *Bot. Gaz. 66 (1918) pp. 381-382.*

For fine morphological and cytological preparations it is necessary that the material be infiltrated with paraffin very slowly. According to the method of the author, the vial of xylol containing the material is first cooled; then melted paraffin is poured carefully over the surface. When properly done the paraffin hardens into a well formed plug at the surface of the xylol, and shows no tendency to slip down later. Solution goes on slowly from the bottom of the plug, and infiltrates the material gradually.

Szombathy, Kolomon. Neue Methode zum Aufkleben von Paraffinschnitten (New methods of affixing paraffin sections). *Zeit. Wiss. Mikr. 34 (1918) pp 334-336.*

Sections of many kinds of material are difficult to keep on the slide during the various processes of staining. In the new methods the fixitive is made as follows: dissolve 1 gm. of gelatin in 100 cc. of distilled water at 30° C., add 1 cc. of a 2% solution of sodium salicylate, cool, and filter; then add 15 cc. pure glycerine. Among the various methods for use, probably the most satisfactory is to smear the fixitive thinly on a clean slide, float the paraffin sections out on the slide in a 2% formalin solution, and gently warm on a warming plate to flatten them. Drain off the excess of formalin solution, and dry the slide. The fixitive keeps well, holds very refractory material on the slide even after prolonged washing in water, is not affected by alkalis, and shows little tendency to take up stains.

Otis, Charles H. Labeling of miscroscopical slides in staining technique. *Science N. S. 47 (1918) pp. 219-220*

To avoid the danger of loss or mutilation of labels on slides during staining, the labels may be written at one with an ink made according to the following formula: dissolve 15 gms. of best cabinet maker's glue in 100 cc. of water at low temperature, add excess of potassium bichromate crystals, and expose to strong light for a week; then filter, and rub in stick India ink to the desired blackness; store in a tightly stoppered glass bottle. The ink keeps well, is easy to use, and is not affected by the usual reagents. An ordinary pen is used for writing and the slides must be clean.

Gage, Simon H. Hand made lantern slides. *Science N. S. 48 (1918) pp. 221-222.*

Where it is desired to use hand drawings for lantern slides, they may be made quickly and satisfactorily by coating clean lantern plates with a thin

solution of some hard varnish and drawing on the varnish surface with a clean pen and India ink. The slides may be used unbound, or they may be bound in the usual manner for permanence.

Osterhout, W. J. V. and **A. R. C. Haas.** A simple method of measuring photosynthesis. Preliminary note. *Science N. S. 47 1918 pp. 420-422.*

To a large amount of water add a little phenolthalein and sodium bicarbonate till a barely perceptible pink color is developed. Some of the solution freshly made is put into a small tube with a branch of an aquatic plant. When the tube is placed in sunlight the color of the solution soon becomes bright pink, as the result of removal of CO_2 from the water during photosynthesis. Under proper conditions the intensity of the colour may be used to estimate the amount of photosynthesis. If after the color is developed, the tube is kept in darkness for some time, the solution becomes colorless again, due to the liberation of CO_2 by respiration acting alone.

Osterhout, W. J. V. A simple method of demonstrating the production of aldehyde by chlorophyll and by aniline dyes in the presence of sunlight. *Am. Jour. Bot. 5; (1918) pp. 511-513.*

An alcoholic extract of chlorophyll is shaken up wlth carbon tetrachloride. The carbon tetrachloride solution is then drawn off and sprayed on filter paper. After the paper has become dry it is sprayed again, and the process is repeated till the paper becomes dark green like a leaf. The filter paper is then fitted over the entire inner surface of a large bell jar and wet with water to make it fit and adhere to the glass. The bell jar is put on a glass plate over a large petri dish containing about 5 cc. of water, and the edges are sealed vaseline. The apparatus is placed in full sunlight and left till the chlorophyll has been bleached to a pale green or pale yellow. Then the water is tested by means of Schryver's text for aldehyde, and a positive result usually is obtained.

It is of great interest that certain aniline dyes, as methly-green and iodine-green, in water solution, may be substituted for chlorophyll. It makes little difference whether CO_2 is present or excluded, but the presence of oxygen is necessary. The author concludes "that the aldehyde is not produced by" the decomposition of CO_2 but rather by the decomposition of chlorophyll. It may be that this method of aldehyde formation a regular step in normal photosynthesis.

WINFIELD DUDGEON.

Physiology.

Mallock, A., Growth of Trees, with a Note on Interference Bands formed by Rays at Small Angles. *Proc. Roy. Soc. B 90. (1918) No. B. 627 pp. 186—191 with 4 fig. in text.*

In this paper is described a device for the measurement of the very minute hourly increase in girth of an ordinary tree, by its effect on the interference bands produced by the incidence of mono-chromatic light on a glass plate resting by one edge on a prison and inclined at a small angle to it. A band of invar is passed round the tree, previously smoothed a little, and made to

pass over two rockers, or shallow drums, which actuate the glass plate and prism respectively. The plate carrying the instrument is screwed firmly to the tree, and the variation in the position of the bands observed by a small telescope placed a few feet away. By this means hourly growths of 0'00003 to 0'0003 of an inch can be observed; and measurements made with the instrument, as shown in the diagram for the Oak, Douglas Fir and Black poplar, show that variations in growth are roughly inversely to variations in temperature, the growth being most rapid when the temperature is lowest. The author suggests that this may be due to variations (with temperature) of the rate of evaporation from the leaves coupled with a nearly constant rate of absorption by the roots: and that while the rate of formation of the new wood is represented by the mean line drawn through the diagram of girth, the divergence from this mean represents the degree of turgescence in the bark and the layers immediately underlying it.

The humidity of the air was not observed so the effect of variation in it could not be calculated, but rain had apparently the effect of increasing the girth.

P. F. F.

Stapleton, R. G. and **Adams, Margaret.** The Effect of Drying on the Germination of Cereals. *The Journal of the Board of Agriculture, XXVI, 4, July 1918, pp. 364—381.*

The problem of the life and death of seeds is one that has at various times received considerable attention, but is by no means yet completely solved. Blackman, Ewart, Demoussy and others have enlightened us on various points, and the writers of the article under review treat from a practical standpoint the effect on germination of the drying of the seeds of cereals.

The process of drying (called "conditioning") is used by the miller and the maltster to ensure uniform germination. On the same principle, drying was utilized for the further investigation of unsatisfactory samples of some cereal seeds.

The cereals used were wheat, barley, rye and oats.

It was found that sound seed if sown immediately after thrashing, gives a percentage of germination much lower than that obtained if the same seed is dried artificially or kept without special drying for 2-3 weeks. In the case of unsound seed drying or keeping may cause a decrease in germination percentage. Grain that has been harvested or stacked in bad conditions, and grain that has commenced to sprout are such seed.

The drying given was for three days at 40° C after receipt of the sample. The keeping meant that the gain remained in its sample bag for two to three weeks after receipt.

The reviewer would remark that it would seem as if some kind of "ripening" goes on during the drying or keeping period. We may only guess what this may be. It is worth remembering that dry integuments are, impervious to gases, and that the drier the seed the better does it stand high temperatures. All these facts may have some connection.

Demoussy (Comptes Rendus 1916, 162, 435) held that a seed contains not only a miniature plant, but also a mass of microorganisms that compete with the plant for oxygen, and suggested that some method of partial sterilisation would be useful. Has drying some such effect?

W. BURNS.

Stiles, W., and Kidd, F. The influence of external concentration on the position of the equilibrium attained in the intake of salts by plant cells. *Pro. Roy. Soc. B. 90 No. B. 632, p. 448 with graphs.*

The authors have been conducting experiments with slices of living tissues to ascertain the position of equilibrium attained in the intake of individual salts, and allied phenomena. The method adopted is that of placing a certain number of washed thin slices of potato or carrot in different solutions the change in the electrical conductivity of which is taken as a direct measure of absorption, due regard being paid to the exosmosis which may take place at the same time. KCl, NaCl or $CaCl_2$ solutions are normally absorbed, the rate of initial absorption increasing with the concentrations of the solutions employed. $Cu So_4$ solution however causes exosmosis in excess of absorption, and thus seems to destory in a way the semipermeability of the cell. This phenomenon is more pronounced if stronger solutions of $Cu So_4$ are employed. Anomalous phenomena in the case of $AlCl_3$ are hoped to be explained in subsequent articles. The authors have not investigated the mechanism of the cell concerned.

Previous work on the subject conducted by Stiles W., and Jorgensen I., and published in *Ann. Bot. Vol. XXIX and XXXI*, supports the view that the method employed is a correct one. In these papers they discussed Czapek's theory of plasma membrane. It may be remembered that Czapek in 1914, started a theory that the mechanism concerned in the passage of salts is the outermost layer of protoplasm, containing lipoid matter. With reference to this theory they say that his experiments were crude and unscientific and his data wrong, that the rate of exosmosis is not a function of surface tension, and that there is 'not a shred of evidence' in support of some of his assumptions such as the one that since "solutions whose surface tension with air is 0·68 are just strong enough to produce exosmosis from the cell therefore the surface tension of the outermost layer of protoplasm towards air must also be 0·68". So they seriously doubt the verity of his simple theory of plasmolytic membrane as the mechanism in the intake of salts.

Therefore the phenomenon of the absorption of salts seems to be more complex than is usually supposed. It is not a case of mere diffusion.

M. BALASUBRAHMANYAM.

Pathology

Hole, R. S. Plant Diseases. *Indian Forester Vol. XLV (1919) 584.*

Hole is of opinion that of recent years there has been a decided tendency to exaggerate the importance of fungi and to regard them as being the primary cause of most plant diseases. He feels that "if we are to make real progress in controlling the diseases of our forest plants, we must develop and expand the study of œcology, or as it is sometimes termed field physiology, and must regard plant diseases as complex problems frequently requiring for their complete solution the combined efforts of a number of experts, such as œcologists, mycologists and biological chemists." A letter written by the late Mr. Ch. Ogilvie Farquharson and reproduced from the Kew Bulletin, 1918, p. 353, expresses similar views. I quite agree with the opinion substantiated by good reasons, but I should be sorry if the authorities of the Forest Department were to show less interest in the work done by their mycologists.

E. B.

Howard, A., and Howard, G. L. C. The Spike disease of Peach Trees. An example of unbalanced sap-circulation. *Indian Forester, Vol. XLV (1919) 611.*

The paper describes the pathological condition of the peach tree which closely resembles the spike of sandalwood. Morphological differences between normal and spiked plants are to be seen in the foliage, the stems, and the roots. Interesting results were obtained by microscopic examination of affected plants at all stages. The leaves show the presence of starch greatly in excess of the normal, twigs and branches contain "an enormous accumulation of starch in the pith, in the medullary rays in the wood and bast parenchyma and there is a sharp line of demarcation, as regards starch deposition, at the junction of the stock and scion." The chemical composition of the leaves show marked differences. The authors are of opinion that the cause of the spiked condition is to be found in the junction between the stock and the scion, the trouble arising from the prolonged unbalanced sub-circulation resulting from an imperfect junction of the stock and scion. They think that "the problem would appear to be considerably clarified if the sandal is looked upon as a root grafted on to its hosts by means of the haustoria and if the association is regarded as symbiotic rather than parasitic." The fact of the transmission of disease by means of grafling and budding would seem to receive a new proof by the hypothesis suggested by the authors.

E. B.

Fungi

Reinking, Otto A. Phytophthora Faberi *Maubl*: the cause of Coconut bud-rot in the Philipines. *Philipine Journal of Science XIV 1919, pp. 130—150.*

The first authentic and reliable investigations into this disease in the Phillipines were made in 1908, and it was reported to have been prevalent and serious in one place for ten years previously. The diseased parts are always found to be infected with bacteria, especially *B. Coli*, but this is considered as due only to secondary infection. Exactly similarly diseased spots were produced by inoculating young coconut buds with *Phytophora faberi* obtained from the black rot of Cacao pods. The two diseases are therefore considered to be due to one and the same fungus. The same species is also believed by the author on the evidence of infection-results to be the cause of cancer of seedlings of Hevea rubber, of the rot of Papaya fruits. The author points out the importance of this. No measurements or other identification marks are given.

Since it is difficult to imagine the fungus of the Coconut bud rot in the Philipines to be different from that of India, the author's identification is contrary to Butlers. But it must be remembered that the difference between the genus Photophthora and Pythium is very small—the latter has sexual spores the former has not—and the more we learn about fungi the more we find how polymorphic they may be on different hosts.

P. F. F.

Algae.

Carter, N. Trachelomonas inconstans, a new flagellate. *New Phytologist. Vol. XVIII, Nos. 3 & 4 pp. 118-119.*

In this paper the writer describes a new species of *Trachelomonas* collected from a rainwater pool near longmoor Pool at Sutton Park, Warwickshire. The distinctive feature is the presence of a prominent nodule or spiny excrescence at the posterior end of the organism. The cell is enclosed in a case whose wall is strongly impregnated with iron and has minute pores within its thickness. These pores become quite distinct after staining with hæmatoxylin.

Bristol, B. M. Retention of vitality by Algæ. *New Phytologist. Vol. XVIII, Nos. 3 & 4 pp. 92-107.*

The author records spores of a large number of algae showing retention of vitality for a very long period, sometimes as many as 70 years. Samples of soil were taken which were bottled 45 to 70 years ago and put in sterilized culture-media. After some time a number of algal species made their appearance in the cultures. Thus two algae, namely, *Nostoc muscorum* Kutz. and *Nodularia Harveyana* (Thwaits) Thuret, were found in nearly all the cultures, even in those which contained soil about 70 years old: *Anabæna oscillaroides* Bory. var. *terreseris* n. var , *Cylindrospermum licheniforme* (Bory) Kutz. and *Chlorococcum humicola* (Naeg.) Rabenh. grew again after 59 years' rest; *Trochiscia aspera* (Reinsch) Hansg., *Stichococcus bacillaris* Naeg. and *Nitzschia Palea* (Kutz) W. Sm. after 48 years' rest and *Anabæna laxa* A. Br. (?) after 46 years' rest.

Carter, N. Studies on the Chloroplasts of Desmids II. *Annals of Botany, Vol. XXXIII, pp. 295-304.*

In this paper the chloroplasts of a number of species of *Micresterias* are described. There is normally one chloroplast in each semicell. Each chloroplast consist of a more or less distinct axile plate parallel to the front faces with a number of ridges arising from it, which project towards the cellwall in different directions. In flattened-celled species the ridges are insignificant or even absent, while in thick-walled species they are very large and sometimes branched. In thinner cells there are more pyrenoids than in thicker ones. Each chloroplast is hollowed out in the centre of the cell to accommodate the nucleus.

Carter, Nellie. On the cytology of two species of Characiopsis. *New Phytologist, Vol. XVIII, Nos. 5 & 6 pp, 177-186.*

The author has worked out in detail the cytology of *Characiopsis Naegli* (A. Br.) Lemm. and *Ch. saccata* n.sp. The interesting points about *Ch. Naeglii* are the internal hollow invaginations of the cell-wall into the cytoplasm, numerous disc-like chromatophores which fill most of the cell cavity, a very large number of nuclei (sometimes more than sixty), absence of pyrenoids, and the presence of oil as its food reserve.

The species *Ch. saccata* is characterised by its acute apex, no internal invaginations of the cell wall, fewer and thinner chromatophores occupying only the peripheral portion of the cell cavity, fewer nuclei and their peripheral position.

She then describes a species of *Characium, Ch.-Angustum* A. Br., for comparison with the two species of *Characiopsis* described above, and points out

the absence of chromatophores and presence of pyrenoids and starch in the former, which characters differentiate the genus *Characium* from *Characiopsis*.

S. L. G.

Biography.

John Goodyear of Mapledurham by G. Claridge Druce, *Suppl.* to the *Botanical Exchange Club Report 1916.*

This booklet which has only just now come into my hands is an account, compiled it is clear with great industry, of John Goodyear, a native of Hampshire, who lived 1592—1664, and was one of Englands early Botanists. He grew in his own garden many interesting plants, including at that time, the very rare Jerusalem artichoke, the tubers of which however he evidently found disappointedly indigestible; but moved later to Oxford, attracted no doubt by the recently opened Garden of Physic. The record of his work lies chiefly in references by Johnson in his second edition of Gerard's *Herbal*, but also by John Parkinson in *Paradisus Terrestris*, William How in *Phytologia Britanica* and Merrett in *Pinax*. Those who know and love their English flora will find interesting details of the first mention of many species as growing in Hampshire or even in England. To others perhaps the chief interest will lie in the striking confirmation afforded of the difficulties the earlier Botanists had in naming their finds, and of the tremendous service rendered by Linnæus in his establishment of a simple and workable system of nomenclature. Some of the names call for no particular remark except as being curiously literal translations into Latin of the common English ones, *e.g. Gramen Parnassi* for the Grass of Parnassus (*Parnasia sp.*). But what chiefly strikes one as illustrating the debt we owe to Linnæus is the length and clumsiness of many of the names, which were used prior to that botanists day. Thus what Linnæus afterwards called, and we now call, *Galeopsis tetrahit*, was *Cannabis spuria altera. flor. purp.* (the purple flowered spurious Hemp). *Potamogeton crispus* L. was known as *Tribulus aquaticus minor quercus floribus* (the lesser waterweed, oak-flowered), and *P. densus* L. as *Tribulus aquaticus minor muscatellae floribus* (the lesser waterweed with flowers of the Muscatell). No doubt "aquatic tribulation," if that is a nearer translation, would fittingly describe this troublesome genus, but what a clumsy way of distinguishing the species, compared with Linnæus' binomial system. The descriptions it may be said were always in English, only the names in Latin. Goodyear's careful descriptions of the four different kinds of Elm (one of which, not the Wych Elm, he called Witch Hasell) are quoted in full as showing the character of his work, and a list is given of his MS. notes and of the very fine collection of books which he presented to the Library of Magdalen College, Oxford.

P. F. F.

Printed and Published for the Proprietor by W. L. King at the Methodist Publishing House, Mount Road, Madras.

THE

Journal of Indian Botany.

VOL. I. JANUARY, 1920. No. 5.

DISTRIBUTION OF LIVERWORTS IN THE WESTERN HIMALAYAS

BY

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A few months ago the writer had an occasion to visit the eastern part of the Chandrabhaga valley, the Lingti plain beyond the Inner Himalayas, and the Beas valley, where collections of Liverworts were made. These collections along with others made in various other parts of the Western Himalayas by the writer during the last few years afford sufficient data for a survey of the general distribution of Liverworts in this region which it is proposed to discuss in this paper. A number of species from various parts of the Western Himalayas has already been published by the writer in the New Phytologist, 1913 and 1914, and the Journal of the Bombay Natural History Society, 1916 and 1917.

GEOGRAPHICAL.

By "Western Himalayas" is to be understood that part of the Himalayan range which extends from the Baralacha pass on the east to the Indus in Gilgit on the west. On the Baralacha pass are the sources of the Chandrabhaga on the southern side while on the northern and eastern sides are the feeders of the Indus and the Sutlej respectively. About this place also the main Himalayan chain gives rise to a branch, the Middle Himalayas, a continuation more or less of the main axis, and running to the west parallel to the above-mentioned range towards its south. The Middle Himalayan range gives rise, near its beginning, to a high ridge, the Bara Bangahal range, running at right angles to it towards the south, which forms the watershed between the Beas on the east and the Ravi on the west. From the Bara

Bangahal range is given off another range towards the west running more or less parallel to the Middle range. This range is known as the Outer Himalayas. The Middle and the Outer ranges may be said to terminate where the Chandrabhaga and the Ravi respectively pierce them to debouch on the plains. Going up one of the feeders of the Chandrabhaga from Kashtwar one has to cross a range which separates the waters of the Chandrabhaga from those of the Jehlum in order to enter the valley of Kashmir.

A few more facts in connection with the geography of these ranges should be borne in mind before discussing the distribution of any group of plants. The Outer Himalayas have a mean altitude of about 15,000 ft., though some peaks rise up to 17,000 ft. Most of the hill-stations for summer for the Punjab are situated on this range at an elevation of about 6—7,000 ft., as Simla, Dalhousie, Murree, etc. The passes in this range are about 8,000 ft. high. The Middle Himalayas have a mean elevation of about 17,000 ft. though some peaks rise to 19,000 ft. The passes range from 13,000 to 17,000 ft. The inner range has a mean altitude of about 18,000 ft. though some peaks rise to more than 20,000 ft. Passes range from 17,000 to 18,000 ft. in Pangi. The lowest pass is the Zojila in Kashmir, 11,000 ft. The Baralacha in British Lahoul is 16,200 ft.

AREA VISITED.

The places visited by the writer are sufficiently numerous and different as regards altitude, etc., to provide reasonably reliable data for the study of distribution though naturally there is a great field for more work in this direction as the area under investigation is so large and diversified while the interior is not easily accessible and requires a certain amount of equipment to be explored.

In the Outer Himalayas the writer has visited Simla, Dalhousie, Murree and some other smaller places but the collections from some of the latter (including Murree) are not sufficiently large to draw detailed conclusions though notes as regards the relative numbers of individuals of Liverworts are available. The Beas valley (Kulu) has also been visited. The Outer Himalayas have been crossed at two places to enter the Ravi valley and at one place (Murree) to enter the Jehlum valley. The Middle Himalayas have been crossed at two places at quite a long distance from each other, the Sauch pass (14,300 ft.) leading to Pangi and the Rohtang pass (13,400 ft.) between Kulu and British Lahoul. The Ravi valley has been explored along the river from Chamba to Chhatrari. The Chandrabhaga has been followed from its source to about 200 miles. The Kashmir valley was entered from the Chandrabhaga valley by crossing the Sinthan

pass. The Inner Himalayas have been crossed only at one place, the Baralacha pass (16,200 ft.). The country beyond that has been visited for about twenty miles up to Lingti Sumdo but the climatic conditions on that side are so uniform over large areas that nothing new would probably be found even much further inwards. The minimum elevation of this region is 14,000 ft. In all cases the forms collected most were from the road-side along the rivers at different levels and at various levels during the crossing of the ranges though short excursions were also often made away from the main road.

General Results.

The more important general conclusions may be stated briefly as follows :—

Most of the species found in the Western Himalayas are thallose.

In the Outer Himalayas the number of species found at a given altitude decreases in proceeding from the eastern end to the west. This decrease is very much more marked if we take into consideration the number of individuals. (*Vide* lists of species at the end.)

As regards vertical distribution, the number increases up to a certain height in going from the plains. The number in the plains is very small. It increases up to about 7,000 ft. and begins to decrease again after that. This applies also to the number of individuals. (*Vide* lists of species at the end.)

On the northern side of the Outer range the same law holds good but the number of species and individuals is much smaller. Thallose forms are chiefly found only near springs. In other places they are as a rule absent.

The horizontal distribution in the Ravi valley probably follows the rule given above but the data are too few to admit of a definite statement being made. (*Vide* list.)

On the southern side of the Middle Himalayas the number is even smaller than on the northern side of the Outer range, and it decreases as we go up.

In the Chandrabhaga valley it can be definitely stated that the number decreases as we go down the river. The number on both sides of the river is very small, but of the two the left bank, *i.e.*, the northern slope of the Middle range is comparatively richer. Pangi is the only part where any foliose forms have been met with. They are absent both to the east and west of it.

The initial level of this valley is very high, being above 8,000 ft. in the Chamba territory. The largest number of individuals is met with between 8,000 and 9,000 ft. in Pangi and up to 11,000 ft. in British Lahoul. The explanation of this difference no doubt lies

in the fact that the latter part is much more open. The initial level of the valley is of course higher in Lahoul than in Pangi.

There are absolutely no Liverworts beyond the Inner range. Of the other cryptogams only one alga which looked like a spirogyra was seen. No fungus, but two or three lichens were observed. One or two species of mosses were noted near running water. Only a single fern plant was seen but unfortunately was not identified. The flowering plants of this interesting region would be dealth with at a later date. It may perhaps be mentoined by the way that red snow due to the unicellular alga *Chlaydomonas nivalis* was observed just below the Baralacha pass on the south side at about 16,000 ft.

The facts of vertical distribution on the southern slopes of the Outer Himalayas can readily be explained by the increase in the rainfall with the increase in height up to a certain limit after which the very low temperature acts as an adverse factor.

One interesting result as regards vertical distribution is that both the highest and the lowest genera of the Marchantiales are met with at the highest and the lowest levels. The lowest genus *Riccia* is represented by *R. robusta* at Lahore (700 ft.) and at Lahoul (11,000 ft.). Of the highest genus *Marchantia*, *M. nepalensis* and *M. palmata* are very common in the plains and the outer Himalayas up to about 7,000 ft., while *M. polymorpha* goes up to about 11,000 ft. in the Chandrabhaga valley. Another genus, *Grimaldia*, about midway between the lowest and the highest genera is also widely distributed in this region. The only Indian species, *G. indica*, is very common from the foot of the Himalayas to about 11,000 ft.

The horizontal distribution is not so easy to explain. That the rainfall is not an essential factor is shown by the fact that it does not differ very much in the different places where collections have been made. Probably temperature connected with a higher latitude has something to do with it. The problem requires more study.

In the Ravi valley the rainfall is not a very important factor as it is not very high and is accompanied by a comparatively low temperature, and Liverworts are thus generally met with only near permanently moist places. A few occur otherwise.

In the Beas valley (Kulu) although the rainfall is not very high but the broad valley is surrounded by hills on all sides and at higher levels there is a luxuriant Liverwort flora which compares very well as regards the number of species and individuals with localities further to the east.

In the Chandrabhaga valley rainfall does not count as a factor at all in the distribution of Liverworts. It is very small and therefore

has no effect. The only place for which rainfall data are available is Kyelang in British Lahoul. It is about six inches during the whole season (June to September) and including the melted snowfall it is not more than twenty-three inches in the whole year. During the greater part of the year it is very cold.

Beyond the Inner Himalayas the dry and cold atmosphere does not allow any Liverwort to grow. The rainfall is extremely small and the temperature very low. Strong winds are usually blowing. The country is a desolate barren desert.

Floristic Details.

Below are given the lists of species found at the different places visited. Of course some more species are certain to be found at every one of these places when a more intensive study is undertaken and more time is devoted to each place, but it may safely be stated that this number would in no case be very large and since this statement affects all the places equally the relative abundance of the Liverwort flora of any locality is not affected. It may also be stated that all these places were visited some time between the end of June and the end of September though several were visited at other times of the year also. The best time for Liverworts in the Himalayas is between July and September. In the plains the best time is late winter and spring.

[1] Mussoorie. (6-7,000 ft.)

Mean Max. temp.—Mean min. temp.— Long. 30° 27′ N. Lat. 78° 5′ E. Average annual rainfall 96″. (Though this hill-station is not situated in the Western Himalayas strictly speaking, but the list would be useful for purposes of comparison of the West and East Himalayan floras.)

1. *Riccia himalayensis* St. 2. *Targionia hypophylla* L. 3. *Cyathodium tuberosum* Kash. 4. *Aitchisoniella himalayensis* Kash. 5. *Athalamia pinguis* Falc. 6. *Gollaniella pusilla* St. 7. *Plagiochasma appendiculatum* L. et L. 8. *P. articulatum* Kash. 9. *Reboulia hemispherica* (L.) Raddi. 10. *Fimbriaria Blumeana* Nees. 11. *F. angusta* St. 12. *F. mussuriensis* Kash. 13. *Grimaldia indica* St. 14. *Stephensoniella brevipedunculata* Kash. 15. *Exormotheca tuberifera* Kash. 16. *Cryptomitrium himalayense* Kash. 17. *Dumortiera velutina* Schffn. 18. *D. hirsuta* (Sw.) R. Bl. nees. (?) 19. *Marchantia nepalensis* L. et L. 20. *M. palmata* Nees. 21. *Aneura indica* St. 22. *Metzgeria pubescens* (Schrank) Raddi. 23. *Metzgeria himalayensis* Kash. (Both species at about 5,000 ft.) 24. *Pellia calycina* (Tayl.) Nees. 25. *Fossombronia himalayensis* Kash.

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[1] Where climatological data are not available the spaces are left blank.

26. *Sewardiella tuberifera* Kash. 27. *Anthoceros himalayensis* Kash. 28. *Anthoceros erectus* Kash. 29. *Notothylas Levieri* Schffr. 30. *Madotheca macroloba* St. 31. *M. Gollani* St. 32. *M. appendiculata* St. 33. *M. sp.* 34. *Lopholea minor* Nees. 35. *Chiloscyphus himalayensis* St. 36. *Frullania himalayensis* St. 37. *F. retusa* Mitt. 38. *Plagiochila sp.* 39. *Solenostema purpurata* Mitt.? 40-42. *Lejeuneas.*

In this locality Liverworts occur in great abundance. Cliffs are covered with huge patches of thallose forms and in suitable places trunks of trees and rocks have dense masses of foliose forms on them.

Kulu, Dulchi pass. (6,000-7,000 ft.).

Long. 31° 50′ N. to 32° 26′ N. Lat. 76° 56′ E. to 77° 33′ E. Aver. annual rainfall, 47.9 in. Mean Max. temp.—Mean Min. temp. (Long. and Lat. are of Kulu Tahsil, the other data apply to Nagar.)

The following species were collected. The references are to the list given under Mussoorie :—

Nos. 1 to 16, 19, 24, 25, 27, and in addition *Plagiochasma simlensis* Kash. and 2 or 3 foliose forms. More would certainly be found if a careful search is made for them. Practically all of these were collected along the road-side within a space of a few yards. *Riccia pathankotensis* Kash. and *Fegatella conica* were collected at a lower level in the same valley. Many of the above species occurs at other levels also in Kulu.

In numbers the flora is almost as abundant as Mussoorie.

(Simla. 6,000-7,000 ft.)

Long. 31° 6′ Lat. 77° 10′ E. Aver. annual rainfall. 63 in Mean Max. temp. 61.9° Mean Min. temp. 51.3°

Nos. 1 to 11, 13 to 17, 19 to 21, 24 to 29, and in addition *Riccia pathankotensis*, *Plagiochasma simlensis* and *Fegatella conica.*

The number of individuals is quite large, nearly as abundant as at Mussoorie.

Dalhousie. 6,000—7,000 ft. (7,687 ft.)

Long. 33° 32′ N. Lat. 75° 58′ E. Aver. annual rain. 86.35″. Mean Max. temp.—Mean Min. temp.

Nos. 3, 7 to 9, 13, 21, 24, *Lophocolea* (2 species), *Chiloscyphus sp.*, *Frullania retusa.* Some more species would no doubt be found but the flora is undoubtedly very poor both in numbers of species and individuals, very much poorer than in the first three localities.

Murree. 6,000—7,000 ft. (7,517 ft.)

Long. 33° 55′ N. Lat. 73° 23′E. Aver. annual rain. 59″. Mean Max. temp. 65.9°. Mean Min. temp. 52.9°.

Full list not available, but flora certainly poor. Very much like Dalhousie, perhaps poorer.

Of the next two localities the first, Pathankote, is at the foot of the Outer Himalayas, and the second, Lahore, is in the plains. The poverty of the species is noteworthy.

Pathankote.

Long. 32° 16 N. Lat. 75° 40′ E. Aver. annual rain. 47″ Mean. Max. temp.—Mean Min temp.—*Riccia pathankotensis*, *Grimaldia indica* and *Fimbriaria pathankotensis* are the only common species, the first two much more so than the third. The first is quite abundant along the river flowing near by.

Lahore. (700 ft.)

Long. 31° 35′ N. Lat. 74° 20′ E. Aver. annual rain. 19.58″. Mean Max. temp. 90.9°. Mean Min. temp. 64.2.

The only Liverworts that are found throughout the year here and there in favourable places are *Riccia sanguinea* Kash., *Marchantia nepalensis* and *M. palmata*. In winter *Riccia robusta* Kash., *R. cruciata* Kash. and *R. pathankotensis* are also seen, the first in pretty large numbers. *Riella indica* St. appears in some years in a water-channel about March. Very rarely *Plagiochasma appendiculatum*, *P. articulatum*, *Grimaldia indica* and *Anthoceros himalayensis* are met with along the river bank. This list is the result of very thorough observations extending over a number of years and can hardly be improved. All the species except the first three and perhaps the fourth also are undoubtedly brought down from other places by the canal water.

The Ravi valley. (about 3,000 ft.)

The following species have been found. The localities, where recorded, are also noted :—

(Chamba, the main town, is situated at an elevation of 3,027 ft. Long. 32° 29′ N. Lat. 76° 11′ E. Aver. annual rain. 47.60″. Mean Max. temp. 77.7°. Mean Min. temp. 56.5°.)

Targionia hypophylla.
Athalamia pinguis.
Grimaldia indica.
Plagiochasma appendiculatum.
P. articulatum.
Reboulia hemispherica.
Sauchia spongiosa. Chamba-Pangi road, about 10,000 ft.
Fegatella conica. Common in moist places on northern slopes; also Chamba-Pangi road.
Wiesnerella denudata. Above Khajiar.
Dumortiera velutina. Common in moist places.

Marchantia nepalensis.

M. palmata.

Aneura Levieri. Chamba-Chuari road.

Pellia calycina. Common in moist places.

Metzgeria pubescens. Chamba-Pangi road, about 10,000 ft.

Calycularia crispatula. Dalhousie-Khajiar road.

Fossombronia himalayensis. Chamba-Pangi road.

Anthoceros sp. Along the Ravi above Chamba.

Madotheca sp. Pangi road.

Radula sp. Dalhousie-Khajiar road; Chamba-Pangi road.

Calypogeia sp.

Chiloscyphus gollani St. Pangi road.

C. argutus, Nees.

Nardia sp. Pangi road.

Plagiochila sp.

Arachniopsis sp. Pangie road, about 11,000 ft.

Lejeunia sp. Pangi road.

Frullania sp.

The number of individuals is very small and specimens are found only at long intervals. *Pellia, Dumortiera,* and *Fegatella* are pretty common in or near running water. *Wiesnerella* has been found in one or two places.

Chandrabhaga valley. (8,000—13,000 ft.)

Riccia himalayensis. Near Salgraon, Chamba-Lahoul.

R. sp. Along with the above.

R. robusta. Above Kyelang, about 11,000 ft. Very curious distribution as it occurs in Lahore also at 700 ft.

Grimaldia indica. Above Kyelang, about 11,000 ft. Also occurs at Lahore, etc.

Athalamia dioica. Near Saor, Pangi.

Mindal Pangiensis. Along with the above.

Reboulia hemispherica. Above Kyelang, about 11,000 ft. Very common in the Himalayas.

Fegatella conica. Near Kilar bridge, Pangi, and elsewhere.

Preissia commutata. Along with the above, and elsewhere.

Dumortiera velutina. At the above place and common elsewhere, also in moist places.

Marchantia polymorpha. Common in moist places.

Pellia calycina. Common in moist places.

Pellia epiphylla ? Near Shaichu, Pangi.

Aneura Levieri. Near Shaichu, Pangi.

Anthoceros sp. Near Sissoo, British Lahoul, about 10,000 ft.

Madotheca ovalis Gottsch. Near Kilar bridge, Pangi.

M. sp. Along with the above.

Radula sp. Along with the above.

Arachniopsis sp. Below Gurdhar pass, about 13,000 ft.

Lophozia sp. Along with the above.

The number of individuals is very small and specimens are met with only at long intervals. Going down the Chandrabhaga to Padar and Kashtwar the Liverwort flora becomes decidedly poorer and hardly any specimens are seen for miles. Going up the Chenab no Liverworts are met with above Jispa, about 11,000 ft.

As stated before no Liverworts occur boyond the Baralacha pass in the country visited. It is probable that none occur in the whole of Ladak.

No. of species in the different localities—

Mussoorie	Kulu	Simla	Dalhousie	Ravi Valley	Chenab Valley	Lingti Plain
42	24	23	11	28	20	0
Southern slopes of the Outer Himalayas.				Between Outer and Middle Himalayas	Between Middle and Inner Himalayas.	Beyond Inner Himalayas.

Rererences to Literature

For many geographical and climatic data the writer is indebted to the Gazetteers of Chamba, Kulu and Mandi, and the Gazetteer of India. Some of the figures about temperature and rainfall were obtained from the Meteorological Observatory, Lahore. The area of which the writer has first-hand knowledge has been indicated in the paper. All the species mentioned have been collected by the writer himself. Descriptions of these will be found in Stephani's *Species hepaticarum* and the following papers by the writer :—

1. Morphological and biological notes on new and little-known went Himalayan Liverworts I, II and III. New Phytologist, 1913 and 1914.

2. Liverworts of the Western Himalayas and the Punjab. I and II. Journal of the Bombay Natural History Society, 1916 and 1917.

CONTRIBUTION TO THE STUDY OF THE INDIAN ASPERGILLI

By

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Aspergillus (Sterigmatocystis) polychromus *Sp. Nov.*

Introduction. It is a very common fact that in India, specially in the rainy season, the culture media in laboratories are covered by a large number of moulds belonging to the most varying genera. In bacteriological investigations, these growths do not matter much, but the difficulties arise when one is dealing with cultures made for the study of human or animal mycoses, a field of research which in India has not yet been fully explored.

The subject of my investigations is the genus "ASPERGILLUS" and its ally "STERIGMATOCYSTIS". A systematic study of Indian Aspergilli has not yet been made and it is hoped that this short contribution may not be without value towards this mycologic investigation.

The species I am now describing is quite a new species and it can be easily recognized both by its macroscopic and microscopic characters. In Nova Goa I have, up to the present, identified the following species :—

A. (*St.*) *niger* Cramer 1859.

A. (sensu stricto) *herbariorum* Wiggers 1780.

A. (*St.*) *sulphureus* Fresenius 1863.

A. (sensu stricto) *orizoae* Ahlburg 1876.

Four other species, one white, two yellow and one green, are now under investigation and I will be very thankful if scientists working in India will be kind enough to send me cultures of *Aspergilli* found in different parts of India.

This study would remain incomplete but for the excellent monograph on *Aspergilli* by Whemer. This work was, very kindly, placed at my disposal by Dr. E. J. Butler, Imperial Mycologist, to whom my best thanks are due.

Origin of the Culture. This species was found in August, 1919, contaminating two Erlenmeyer flasks containing Endo's medium and plain agar. One of the cultures was grey, slightly brownish, the other had a light chocolate colour. On cultivating the fungus from these two sources, I was able to identify both these cultures as

belonging to a same species. The colour of the fungus changes, but variations are always uniform according to the age of the culture.

General Colour of the Culture. The colour of this fungus is white *platré* during the first 24 hours; on the second day a slight greyish tone is noticed, on the fourth the culture assumes a light marine blue, on the sixth it becomes greyish blue, on the 8th the greyish tone is predominant and the culture presents a beautiful *gris souris* colour. From the first to the second week the colour changes into a deep brownish, passing through a slightly violet tone. Later on the culture is of a deep chocolate colour, which two months later becomes very clear.

Morphology and Mycological appearance—The morphology of the fungus is the same as noted in the general description of the fungi belonging to these genera. The following elements call forth our attention :—

Conidiophores—length maxim. 650 micr., minim. 112; average taken on 35 conidiophores 275 micr.; breadth 3 to 6 micr.; wall thickness 0, 5 to 1 micr.

Columellae almost always ovoid and claviform, very seldom spherical. When old, they show a brownish pigmentation, more concentrated in the superior pole. Diameter of the spherical type 8 to 15 micr. Ovoid: length maxim. 25 minim. 10, average taken on 44 columellae, 13 micr.; breadth maxim. 20, minim. 4, average taken on the same number 10, 5 micr.

Sterigmata very densely inserted, generally on the anterior $\frac{3}{4}$ of the columella, rarely radiated. In old cultures a deep brownish pigmentation is noticed. *Primary Sterigmata* ovoid or claviform, 5 to 10 micr. long, 3 to 4 micr. broad. *Secondary Sterigmata* ovoid or lanceolated 5 to 8 micr., long, 3 to 4 micr. broad.

Conidia round, finely punctuated, bluish green at first, light brown at a latter stage, finally chocolate colour; 2, 5 to 5 micr.

Heads (Columella + Sterigmata + Conidia) round and elliptical. Diameter of the round forms; maxim. 55, minim. 36, average 42 micr. Dimensions of the elliptical forms: length maxim. 80, minim 10, average taken on 20 heads 45 micr.

Perithecium yellow with a greenish tone, found only in old cultures aged at least two months; 30 to 35 micr. of diameter.

Cultural characters. Plain agar. Good development, the cultures having the following coloration: 48 hours, white *platré*; 3 days, greyish; 5 days, slight bluish tone; 9 days, *gris souris*; 2 weeks, chocolate brown; 3 weeks, deep chocolate; 2 months, clear chocolate; 3 months, idem.

Glucosed sabouraud—Idem, very good development, the colours being more vivid.

Maltosed sabouraud—Very weak development; colours idem.

Endo's medium—Idem as on glucosed sabouraud.

Lemon—48 hours, weak development, clear blue; 3 days, greyish blue; I week, deep blue with a greyish tone; 2 to 3 weeks, idem.

Bread paste—48 hours, weak development, blue greyish green; 1 week, idem; 4 days, clear green; 2 to 3 weeks, dirty green.

Banana—3 days blue *outremer*, good development, 5 days, idem; 2 to 3 weeks idem with a greenish tone.

Rice; paste—1 week, poor development, of white slightly green colour; 2 to 3 weeks, good development of the same colour.

Carrot—3 days, good development, yellowish green; 5 days, idem; 2 to 3 weeks, green with yellowish tone.

Potato—3 days, good development, white slightly green; 1 week, green straw colour; 2 to 3 weeks, dark green.

Glycerinated potato—10 days, poor development, white colonies; 2 weeks, idem; 3 weeks slightly blue greyish; 1 month, deep grey.

Coagulated milk—The culture is blue slightly greenish, the greenish tone becoming predominant after 2 to 3 weeks.

Pineapple juice—48 hours, clear blue, isolated colonies fluctuating on the surface of the liquid; 3 days, idem, the colour being the same but with a slight greyish tone; 5 days, the colonies become confluent and form a very consistent membrane; 1 week, the same colour, the bluish tone becoming more pronounced; 10 days, greyish blue, 2 to 3 weeks, greyish to gris souris and the bluish tone changing into the greenish.

Mango juice—The colour of the culture is the same as in the pineapple juice, but the culture shows the form of a ring, strongly adhering to the wall of the tube.

Bouillon—48 hours, minute isolated colonies of white bluish colour, becoming greyish blue after 1 week and finally dark grey.

Glucosed bouillon—Idem, the colonies being more abundant and confluent and forming a membrane on the surface of the liquid.

Maltosed bouillon—48 hours, greyish blue membrane; 4 days, idem, the vegetative mycelium (inferior face) having the appearance of a gelatinous mass and a brownish yellow colour; 4 days, the grey tone becomes more pronounced; 3 weeks, dark grey with greenish tone.

Straw bouillon—idem without the final greenish tone.

Bouillon of vegetables—Idem, the mass of the vegetative mycelium has the same gelatinous appearance as in the *maltosed bouillon*.

Inoculations—One rabbit and one guinea-pig inoculated by intravenous injection remained healthy till the end of the experiment.

On account of the variations of the colour in the cultures of this

fungus, I have named this species *Aspergillus* (*Sterigmatocystis*) *polychromus* My best thanks are due to my Assistant Dr. J. A. de Carmo Vaz, for valuable collaboration given to me in the course of this study.

Aspergillus (Sterigmatocystis) polichromus, species nova, fungus saprophiticus, ostendens, cultionis subjectus, coloris variationes secundum cultionis actatem uniformes, sclicet: albo-niveum colorem in nitio (24 horis), suaviter cinereum (2a. die), suaviter ceruleo (4a. die) et deinceps succesive cinereum, violaceum, ravum (post 2 hebdom.) aquiloalbum.

Elementa morphologica notabilia:—*Conidiophora* 601 (micr longa maxime, 112 minime, 275 medie:—*Columellæ* generatim ovoides vel claviformes, ostendentes pigmentum aquilum superiori polo, in vetustate, 10 ad 25μ longae, 4 ad 20 latae, cum sterigmatibus *primariis*, sc. ovoid. vel lanceolat. 5 ad 10μ longis et 3 ad 4 latis; et *secundariis* sc. ovoid. vel lanceolat. 5 ad 8μ langis et 3 ad 4 latis; *Conidiæ* rotundae 2, 5 ad 5μ in ambitu;—*Perithecia* in cultionibus tantu veteris a 2 saltem mensibus inveniuntur, 30 ad 35μ longa, aliquantulum minus lata, cum *ascis* rotundis et in unoquoqu 4 ascosporis.

MILIUSA AND SACCOPETALUM.

(FAMILY ANONACEÆ)

BY

J. R. DRUMMOND, F.L.S.

The genus **Miliusa** was founded by Alphonse De Candolle (in Mem. de la Soc. de Phys. et d'Hist. nat. de Geneve vol. V., 1832) on a plant collected by Leschenault de la Tour " in montibus Cotta-lam dictis ad peninsulæ indicæ meridiem ". Cotta-lam has been indentified with Courtallam in the Tinnevelly District of the Madras Presidency (S. India).

The generic character, rendered into English, is as follows :—

Corolla gamopetalous, campanulate, three-lobed. Stamens 12? with slender elongate filaments, and very small anthers. Receptacle ovoid. Ovaries indefinite, 2-ovuled, the ovules superposed. Carpels free.

From the detailed description we gather further that the *Miliusa* was a low shrub with bifarious elliptic leaves, and solitary axillary flowers, consisting of a trifid gamopetalous corolla (or three petals, about nine lines long, connate for half their length) concave or hooded at the base concealing the pedicel and the small calyx of three sepals, the petals folded internally so as to form three hairy fimbriate appendages, one opposite each of the main lobes of the corolla. The anthers, scarcely 1/20 line long, are inserted on the receptacle, supported by slender glabrous filaments, and rounded. The receptacle is very hairy. De Candolle observes "Genus ex habitu, corolla gamopetala, basi concava, et interne reduplicata, distinctissimum."

Plate No. iii accompanying the Memoir represents "*Miliusa Leschenaultii*, Alph. DC." which is manifestly the *Miliusa indica* of the text, although at the right hand upper corner a portion of a leaf (figure 8) is included which is not accounted for in the letter press, and may belong to some other plant.

From this illustration it appears that the torus in *Miliusa indica* consists of two portions, of which the lower, constituting about one-fifth of the whole, is glabrous, the remaining four-fifths being pilose; the stamens are inserted at the division between these two portions and the corolla, at the base of the lower (glabrous) fifth; one corolline whorl is visible, the lobes of which are connate for about two-thirds of their length, and prolonged, "hooded"—or rather saccate—, at their bases, completely hiding the small sharply refracted "calyx", of which the segments are rather strongly ciliate;

the appendages of the corolla appear as tufts of hairs inserted at the base of the torus, remaining after the petals have been taken away. It should be here noted that the whorl which the author described as a calyx may have been in fact an outer series of petals, conforming, as in certain allied species, to the true sepals, which in this case, however, must have been highly caducous.

In 1834 Wight and Arnott (Prodromus p. 10) under "*Miliusa indica* (Lesch.)" reproduced A. Le Candolle's leading characters, but assigned them to "Wall. L.n. 5433," quoting as a synonym "Uvaria ciliata, Heyne MSS." There is a specimen at Kew ticketed *Uvaria ciliata*, Heyne Tenmalej near Courtallam, July 1815," and on the same sheet is a second ticket from which it seems probable that the citation of "Wall. L.n. 5433" may refer to this specimen or to a duplicate.

In April 1835, Wight got a plant at Courtallam which he ultimately referred to *Miliusa indica*, and in the following July and August he collected further specimens which together with the April gathering have since (1866-67) been distributed from Kew as No. 34 of the Indian Peninsular Collections. These later gatherings (in part) resemble "*Uvaria ciliata*, Heyne" so far as can be judged, but Heyne's specimen is not in fruit: No. 34 of Wight has drupes and matches an example from his own Herbarium, without date or original locality, with which is now attached a description in his own handwriting. This description, however, seems to have belonged to the specimen distributed under No. 33 as "*Miliusa montana*, Gardner" (which in Fl. Brit. Ind. i. 86 is reduced to M. indica) and to have been pinned to the sheet where it is now found by accident. A pencil note on the sheet from Wight's own Herbarium (in Sir J. D. Hooker's handwriting apparently) points out that the plant there represented differs from No. 33 by the ripe carpels being sessile and pubescent-tomentose. This form (No. 34 in part) seems to have received from Wight the manuscript name of "*M. affinis*". Nothing on these sheets can be referred to Alph. De Candolle's *M. indica* unless we assume—

(1) that the sepals, which in Nos. 33 and 34 Herb. Pen. Ind. are manifest, may sometimes fall off at a very early stage, or

(2) that the sexes are diclinous and that the structure of the androecium differs in the male and female flowers very widely, or

(3) that the arrangements of the floral whorls is remarkably unstable.

How far any parallel to the degree of instability that must be supposed in this case has been observed in other Anonaceæ is a question which may be deferred for the present. In the "Illustrations" i. p. 68 (1840), Wight met this difficulty by suggesting that De

Candolle was misled by imperfect material, and this theory was adopted and elaborated in the same year by J. J. Bennett, when dealing with a tree found by Horsfield in the "Banyumar Province" of Java, on which Bennett's genus *Saccopetalum* was founded (Plant. Jav. Rar. p. 165 t., xxxv : 1840).

Bennett remarked that since the publication of the family in De Candolle's Prodromus two new genera of Anonaceæ had been constituted, viz., *Miliusa* and *Hyalostema*. With "Hyalostemma we need not concern ourselves further than to say that it was coined by Wallich without any diagnosis, for a plant which had been duly described by Roxburgh (Fl. Ind. ii. 660) as *Uvaria dioeca*. Bennett's note adds nothing to the history of "Hyalostemma" (which has subsequently been dropped by common consent), and his discussion of De Candolle's plant does not advance the history of *Miliusa*, because he postulates the identity of Wight's species with "*Miliusa Leschenaultii*", which, as we have seen, can only be accepted by making alternative assumptions, in support of which no proof has been put forward.

As it happens, a good deal of the reasoning expended on the matter is invalidated by facts since discovered. Speaking of that group of Anonaceæ, of which *Miliusa* has been taken as the type, Bennett writes :—

"The stamina also are subject to some modifications, less extensive however than the character and description of *Miliusa* given by M. Alph. De Candolle would lead us to believe. Their number in that genus, according to my observation, is about 27 instead of 12, forming three alternating series, in each of which two are opposed to each of the inner, and one to each of the outer petals". Now, in *Miliusa nilagirica* Beddome, Ic. Pl. Ind. Or. t. lxxxviii (1876) there are but eight stamens: that this is a *Miliusa* no one probably will dispute, and in that case Bennett's estimate of the stamens as "about 27" obviously calls for revision. It seems even possible that this plant and not either of Wight's Miliusæ, was the true *M. Leschenaultii*. The glabrate middle surface and margin thickened towards the apex of the petals, which are given as distinctive of *M. nilagirica* are approached in some examples of *M. montana*, Gardner, and these differences are not sufficient, perhaps, to mark off Beddome's species from that of De Candolle. Beddome's illustration lxxxv serves to contrast *M. affinis*, Wight MSS.,—which is there figured as "*M. indica*",—from *M. Leschenaultii*. The number of the stamens in the last differs, as observed, from that *M. nilagirica*, but it may be questioned whether the number is so fixed in this group as was supposed by Bennett. As regards the structure of the valvate petals he has very justly noted that the gamopetaly of the inner row is less

real than apparent, being due to a partial cohesion of their edges, which in certain other Anonaceæ takes place, so to speak, in an inverted order, the cohesion being at the tipes, so as to form a canopy over the androgynœcium, somewhat as in *Vitis*.

More disputable matter is involved in his next argument, as follows :—

"Now the three supposed divisions of the calyx in M. De Candolle's figure alternate with the three cohering divisions of the corolla and consequently represent the outer petals, the calyx being thus altogether omitted. In the description this deficiency seems to be supplied by the three supposed internal appendages opposite the base of the cohering petals, of which, however no traces are observable in the figure . . . .", and he adds, "This supposition" (i.e. that the outer row of petals was taken for a calyx) "may at least serve to explain the description; it is less easy to account for the figure, but it may be presumed that the artist, aware that the plant was described as having only three division to its calyx, was satisfied with "having found that number of sepaline parts, and it is possible that the true sepals (easily detached at maturity as in *Saccopetalum* and *Hyalostemma*) may have fallen off during the process of manipulation ".

It is obviously just as likely that the "sepals" were naturally caduous; but the case of the fimbriate processes rests on a distinct footing, because, although somewhat disguised in the drawing by a dotted line (b), which indicates the point of insertion of the corolla, they are quite clearly shewn in the figure. These organs are perhaps correlated with the special structure of the androgynoecium, and the saccate, probably nectariferous, development of the "petals". Traces of like tufts seem to the writer to be present in other species of *Miliusa* as well, and it may be that the degree of their development is variable even in the same species, as is seen to be the case with the so-called petal-claw or gland in certain species of *Grewia* from the same parts of S. India.

Further material and particularly observations in the field may necessitate emendation, but in the meantime local botanists will presumably keep up *Miliusa Leschenaultii* (type of the genus), *M. affinis*, *M. Montana*, and *M. nilagirica* as distinct, though closely allied species. If facts should be adduced in the future to shew that *M. Leschenaultii* and *M. nilagirica*, or *M. affinis* and *M. montana* should be looked upon as a single unit, it is comparatively easy to carry out the necessary technical corrections.

To return to the history of the genus,—Bennett, having as he believed disposed of *Miliusa Leschenaultii*, went on to establish his

new genus *Saccopetalum*; but as is shewn in the Genera Plantarum (Vol. I, p. 28), the only distinction between *Saccopetalum* and *Miliusa* lies in the saccate petals of the former, whereas A. De Candolle in his description no less plainly than in the accompanying figure has given this very character as belonging to the only species of *Miliusa* known up to the time when Bennett wrote, because what is now *Miliusa Roxburghiana*, Hook. fil. & Thom. was excluded and referred to the factitious Hyalostemma. In the Flora Indica, Vol. I, p. 92, the generic character was amended by restricting *Miliusa* to those species that have not more than two ovules, but as further species were examined this distinction seems to have been found untenable, though retained in a modified form in the Flora of British India, due warning being at the same time conveyed that *Saccopetalum* had been reduced to *Miliusa* by Baillon (Hist. des Plantes I 244).

Hook. fil. & Thom. at the same time pointed out that *Saccopetalum tomentosum* is intermediate between *Saccopetalum* and *Miliusa*, i.e. presumably between *Miliusa affinis* of Wight MSS. and the Javan *Saccopetalum Horsfieldii* of Bennett. Baillon (l.c.) and Prantl. (Nat. Pflanzenfam. III 2.29) do not even admit *Saccopetalum* to the rank of a subgenus. Comparing the number of the ovules in the different genera included in the "Genera Plantarum" under Miliuseæ we hardly find sufficient ground for maintaining *Saccopetalum* as an independent genus; in *Orophea*, it is true, it is said that there are never more than four ovules, and in *Alphonsea* always more than four, with eight as a maximum; but in Bocagea, which is admittedly closely allied to *Miliusa*, they are given as 1—8. In the critical note now attached to a sheet from his own Herbarium, written up at Kew (by Sir J. D. Hooker probably) as '*Miliusa affinis*, R. W.', mentioned above—Wight has observed "On examining the ovaries of *Miliusa* somewhat advanced, I find them containing 2-3 and, once or twice, 4 ovules superposed; also probably there are two or three species distinguished by the stamens being few or numerous and the carpels glabrous or hairy". Whether therefore we assume that the number of maturing ovules differs in the species, or that it varies with the individual, little weight can be attached to this character in discriminating *Miliusa* from its allies. It appears, moreover, that in *Saccopetalum* the number or the ovules is not always six or more; in the 'Flore Forestière de la Cochinchine' at plate 38 (1881) Pierre has figured and described as *Miliusa Bailloni* a tree so closely allied to *Saccopetalum Horsfieldii*, that the two could not properly be referred to different genera, but in this plant it is expressly noted that the ovules are not more than four in number.

In attempting to frame an amended definition of the genus *Miliusa*

two special difficulties are encountered; the one is due to the obscurities, above stated, which surround De Candolle's type; the other is presented by the genus *Phæanthus* of Hook. fil. and Thomson (Flora Indica p. 146). Phæanthus cannot be discriminated from *Miliusa*, whether *Saccopetalum* be merged in *Miliusa*; or accepted, save by the structure of the staminary whorl; but Baillon (*Adansonia viii 1868, pp. 312 et seq.*)— has given reasons for thinking that this character does not in fact possess the value formerly assigned to it, and *Phæanthus* is so nearly akin to the type of *Saccopetalum* in habit, in the structure of the outer floral whorls, and of the ovary, that this genus also should perhaps be reduced to *Miliusa*.

The arrangement of the highly natural but difficult family of the Anonaceae might possibly be simplified, if, instead of attempting to distinguish between 'sepals', and 'petals', the floral envelope were treated, for taxonomic purposes, as a single perianth, consisting of subsidiary, sometimes sharply differentiated, whorls.

In the subjoined description, for the sake of convenience, the accepted characterization of the perianth whorls has been followed; the species placed under *Phæanthus* of Hooker and Thomson have, for the same reason, been excluded.

MILIUSA

Genus Anonacearum imprimis ex-indicatione Leschenaultu ab Alph, Candolles in Mem. Soc. Phys. et Hist. Nat. Genev. vol. V (1832) p. 37, t. iii supra speciem unicam Indicam constitutum, nunc propter plures species nuper recognitas iterum ut sequitur breviter descriptum.

Flores hermaphroditi vel unisexuales, in cymis, vel fasciculis dispositi, aut in axillis solitarii. *Sepala* tria, inconspicua, basi vix connata. *Petala*, aestivatione valvata, per duo verticillos valde dissimiles disposita, exteriora parva sepaloidea, nonnunquam refracta, interiora majora, vix androecium celantia, membranacea vel hyalina, nec unguiculata, nec ad apicem producta, versus basin concava vel saccata, rarius explanata, marginibus plus minus cohærentibus, rarissime discretis.

Torus productus subglobosus vel cylindricus, spice aliquando truncato. *Stamina* 8–12, aut ad 36 in gradibus disposita, ver indefinita antheræ subdidymæ, loculis contiguis ovatis vei rotundatis, extrorsæ, saepius minutæ; filamenta manifesta, attenuata, vel connectivo incrassato, plus minus apiculato, vix superne dilitato. *Carpella* numero indefinita stipitata, matura forma oblonga, ellipsoidea, vel globosa, parum succulenta, indehiscentia, in pseudocarpum nunquam coalita:—ovula in venterali sutura (an semper?) affixa, saepissims bina (rarius unico per abortum superstite), vel indefinita:—

stylus abbreviatus, stigmate simplice oblongo. *Semina* 1-6 (vel plura ?), lateraliter compressa vel in sectione transversa cuneiformia.

Arbores, arbuscula, vel frutices humiliores, per regiones Asiae australes, et Indo-Sinenses, usque ad Australiam subtropicam dispersae. Species circa 21.

It is usual to ascribe the foundation of Miliusa to the discoverer of the type species, but it does not appear that he laid claim to anything beyond the dedication, and the descriptions throughout are evidently the work of De Candolle. The present description is necessarily tentative and is put forward partly as a contribution towards a much needed revision of the family, or at least of that group to which Miliusa naturally belongs. Much better material, in the fruiting stages particularly, must have accumulated since the account in Genera Plantarum was published.

The writer will be grateful for any specimens of Miliusa, Saccopetalum, or Phæanthus that can be spared on loan or otherwise for study at Kew in order to complete a key to the species which it is proposed to include under Miliusa.

CONTRIBUTIONS TOWARDS A FLORA OF BALUCHISTAN.

From materials supplied by Col. J. E. B. Hotson, I.A.R.O.

BY

E. Blatter, S.J., Prof. F. Hallberg and C. McCann.

St. Xavier's Coll., Bombay.

(*Continued from last issue*)

Ficoideae—*Contd.*

Mollugo *L.*

Mollugo nudicaulis *Lam. Dict IV, 234.* Loc.: Rodkan (W Kolwa), about 85 miles E. of Turbar, about 1,800 ft. (no. M 225A); Manguli, 26° 45′ N, 65° 21′ E, about 2,600 ft. (no. M 225C); Awaran, Kolwa, 26° 24′ N, 65° 12′ E, about 1,750 ft. (no. M 225 C bis). Fl. and fr. in April, 1918.

Vern. Name : Askkah (Bal.).

Umbelliferae.

Pycnocycla *Lindl.*

Pycnocycla aucheriana *Boiss. in Ann. Sc. Nat. (1844) 88.* Loc.: 5 miles N. of Mand, about 1,000 ft. (no. M 73); near Kulban (W. Kolwa), about 85 miles E by N of Turbat, about 2,400 ft. (no. M 73 A); Panjgur, about 3,100 ft. (no. M 170, M 73 B, M 73 C.) Fl. in May 1918.

Uses : When people are thirsty they chew the leaves of this small bush. It is said to be very cooling.

Vern. Names : Bibi Butag (Bal.) Kemar (Mandi Bal.), also called Sagi dontan in Panjgur, which is strictly a quite different plant.

Pycnocycla caespitosa *Boiss. and Hauskn. in Boiss. Fl. Or. II, 953.* Loc.: Harboi, 18 miles ESE of Kalat, 9,000 ft. (no. 33). Fl. and Fr. in August 1917.

Uses : Eaten by sheep, etc.

Vern. Name : Humukh (Br.).

Pycnocycla sp. Loc: Below: Harboi, 15 miles ESE of Kalat, 8,300 ft. (no. 81).

Pimpinella *L.*

Pimpinella Stocksii *Boiss. Fl. Or. II, 865.* Loc.: Kalat, 7,000 ft. (no. 4); Garmkan, 12 miles NE of Panjgur (no. M 142 C). Fl. in August 1917.

Uses : The grain is crushed, mixed with water, hot or cold, and swallowed as a remedy against pain in the stomach.

Vern. Names : Harpir (Bal.), Isbot (Br.)

Ammi *L.*

Ammimaius *L. Gen. 334.* Loc.: Panjgur, about 3,100 ft. (no. M, 142, M 142 A, M 142 B). Fl. in March 1918.—Fr. in May 1918.

Vern. Name : Jangli Saleri (Sin.), Harpir (Bal.)

DUCROSIA *Boiss.*

Ducrosia anethifolia *Boiss. Fl. Or. II, 1036.* Loc.: Siahen Damb, about 36 miles E by S of Panjgur, about 3,800 ft. (no. M 176 C); S. end of Gar Pass, about 28 miles E by S of Panjgur, about 3,800 ft. (no. M 176 D); Benn Chah, 21 miles N of Surab, about 6,200 ft. (no. M 383). Fl. in April 1918.—Fr. in April and July 1918.

PSAMMOGETON *Edgew.*

Psammogeton biternatum *Edgew. in Trans. Linn. Soc. XX, 57,* Loc.:: Turbat 63° 4′ E, 25° 58′ N, about 600 ft. (no. M 52); Nagak (W. Kolwa), about 87 miles E by N of Turbat, about 2,400 ft. (no. 50 B.) Panjgur, about 3,100′ (M. 52 A.) Fl. in Feb. 1918.

Vern. Names : Isbot, Isbotk, Isbok (Bal. Br.).

Rubiaceae.

GAILLONIA *A. Rich.*

Gaillonia Aucheri *Jaub. & Sp. Illustr. I, 140.*—Loc.: Nasirabad, 23 miles W. of Turbat, about 400 ft. (no. M 59); Mazhdalu, 20 miles S. of Panchgur, about 3,000 ft. (no. M 59 B); Tumb, 46 miles W. of Turbat, about 600 ft. (M 594)—Fl. and fr. in March 1918.

Uses: The plant is soaked in water and the liquid used to wash babies with pains in their stomachs.

Vern. Names: Tuso (Bal.), Khartusa (Br.).

Gaillonia eriantha *Jaub. & Sp. Ill. I, 145, t. 78.*—Loc.: Benn Chah, 20 miles N. of Surab, about 6200 ft. (no. M 385; Surab, 28° 29′ N, 66° 16′ E, about 5,700 ft. (no. M 379).

Vern. Name: Pihunpulli (Br.). This name means " white flower ", and is applied to lots of different plants.

Gaillonia hymonostephana *Jaub. & Sp. Ill. I, 146, t. 79,* var. **macrocalyx** *Blatt. & Hall. var. nov.*—Calyx post anthesim 12 mm diametro. Par foliorum summum infra calycem cum stipulis formans quasi involucrum hyalinum suaequalitor 6-lobum, lobis acutis, ovatis, uninerviis hispidulis. Rami foliaque minutim scabrida.

Loc.: Baranlak, 28 miles S. of Wad, about 4,100 ft. (no. 379). Fl. and fr. in Oct. 1917.

Gaillonia macrantha *Blatt. & Hall. spec. nov.*—Suffruticosa, ramosissima ramis erectis opposite et dichotome vel trichotome ramulosis. Rami albidi, ancipites vel trigoni propter folia opposita vel ternata decurrentia. Ramuli teretiusculi. delicatule striati, dense, minutim atque rigide pubescentes, olivacei. Folia opposita vel ternata, basi cum stipulis brevibus brevissime connatis, stipulis annulm formantibus,l ineari-subulata, atro-olivacea, apice subspinosa, usque ad 20 mm longa, infima et summa multo breviora, uninervia, rigide pubescentia, margine revoluta.—Flores terminales, cyman dichotomam vel trichotomam formantes. Calyx 5 mm longus, densissime hispidissime lanatus (multo densius quam in G. eriantha) ita quidem ut superficies conspici nequeat, tubulosus, 5-lobus usque ad medium, lobis lanceolatis acutis. Corolla hispida, tubo angustissimo, fauce valde ampliato, 5-loba, lobis oblongis obtusis. Stamina brevissima,

antheris apicem corollae attingentibus, filamentis insertis immediate infra sinus limbi corollae; stylus inclusus; stigma bifidum, glandulosum. Fructum non vidimus.

Differt a Gaillonia eriantha sequentibus: Rami sunt ancipites vel trigoni; Calyx et corolla multo hispidiores; annulus stipulis uniformibus tantum formatur.

Loc.: Near Quetta.—Fl. in Aug. 1918.

Gaillonia sp. Loc.: Hills S. of Chambar (Kolwa), 26° 9′ N, 64° 42′ E, about 2,000—2,200 ft. (no. M 259).

GALIUM *L.*

Galium aparine *L. Sp. Pl. 157.* Loc.: Khudabadan, ¼ mile N. of Panjgur, about 3,100 ft. (no. M 178).—Fl. and fr. in March 1918.

Vern. Name: Lichok (Bal.). Sticks to hands and clothes, which probably explains the name, "lich" being clinging mud. They say "lich" or "malich" to a camel on muddy ground, meaning "slippery" or "don't slip".

Compositae

VERNONIA *Schreb.*

Vernonia cinerea *Less. in Linnaea, IV, 291 and VI, 673.*— Loc.: Kanoji, 47 miles N. of Las Bela, about 3,200 ft. (no. 383); Chibi, about 63° 8′ E, 26° 19′ N., about 1,600 ft., growing in and on border of irrigation channels (no. M 125); Hills of Chambar (Kulwa), 26° 9′ N, 62° 42′ E, about 2,000 ft. (no. M 194 A).—Fl. and fr. in March and April 1918.

Vern. Name: Aghud (Br.).

ADENOSTEMMA *Forst.*

Adenostemma viscosum *Forst. Char Gen. (1776) 90.*—Loc. Near Ornach, about 3,300 ft. (no. 315). Fl. and Fr. in May 1917.

Vern. Name: Wal.

GNAPHALIUM *L.*

Gnaphalium pulvinatum *Del. Fl. Aegypt. 122, t. 44, f. 1.*—Loc.: Nag (W. Kolwa), about 83 miles E. by N. of Turbat, about 2,300 ft. (no. M 242); North Parpuki Kaur, 12 miles SSW of Panjgur, about 3,300 ft. (no. M 197); Ispikan, 16 miles NE of Mand, about 1,050 ft. (no. M 79);—Fl. and fr. in March and April 1918.

INULA *L.*

Inula grantioides *Boiss. Fl. Or. III, 195*; Loc: Between Msshkai and Pirandar Valley, about 2,500 ft. (no. 248); Awaran, 26° 24′ N, 65° 12′ E, about 1,750 ft. (no. M.2B).—Fl. and fr. in April 1918.

Vern. Names: Kolmir, Kolbur (Br.), Kolmir (Bal.).

PULICARIA *Gaertn.*

Pulicaria glaucescens *Jaub. and Sp. III. t. 349.*—Loc.: Rari Ban, 170 miles S. by W. of Kalat, 2,300 ft. (no. 284); Gwambuk, about 60 miles S. by E. of Panchgur, about 2,700 ft. (no. M 19B).—Fr. in April 1918.

Vern. Names: Kunchito (Bal.), Kunchid (Makrani Bal.), Ler Mazonk (Br.).

Pulicaria Boissieri *Hook. f. in Hook. f. Fl. Brit. Ind. III, 300.*—Loc.: Near Manguli, 197 miles SSW of Kalat, about 2,450 ft. (no. 242); Gwambuk, about 60 miles S. by E. of Panjgur, about 2,700 ft. (no. M 19C.)

Vern. Name: Kunchito (Bal.).

Pulicaria carnosa *Burkill in Working List Fl. Pl. Baluchistan (1909) 39.*—Loc.: Padigazu, 40 miles SSW of Panjgur, about 2,700 ft. (no. M19). Fr. in Dec. 1919.

Uses: Very favourite camel grazing; has a strongly apperient effect. Horses will eat it at a pinch. The effect in them is not marked (Hotson).

Vern. Name: Kunchid.

Pulicaria crispa *Benth. in Gen. Pl. II, 336.*—Loc.: Teghab (no. 190); Kochau 122 miles SW of Kalat, 4,150 ft. (no. 5 A); Pirandar, 205 miles SSW of Kalat, about 1,900 ft. (no. 24C); Shambaz Kalat, about 24 miles SSW of Panjgur, about 2,800 ft. (no. M199); Rek Chah, 11 miles E of Chambar (Kolwa) about 1,800 ft. (no. M133C); Panjgur (no. M133D); Hills S. of Chambar (Kolwa) 26° 9′ N, 64° 42′ E, about 2,000 ft. M133B); Mohtaji Kand, about 22 miles SW of Panjgur, about 2,800 ft. (no. M133, M133A).—Fl. and fr. from March to May 1918, from Aug. to Sept. 1917.

Uses: The plant is boiled and the liquid given to children in whose stomach milk turns sour.

Vern. Names: Boraku (Bal.), Rambo (Br.), Pihupulli (Br.), Bo-i-Madaran (Bal. Br.).

Pulicaria sp. Loc.: Turbat (no. M2); Ispikan, 16 miles NE of Mand, about 1,050 ft. (no. M2A). Fl. and Fr. in March 1918.

Vern. Names: Kolmir (Bal.), Kolbur (Br.).

XANTHIUM *L.*

Xanthium strumarium *L. Sp. Pl. (1753) 987.*—Loc.: Surab, 43 miles S. of Kalat, 5,750 ft., grows beside irrigation channels (no. 106). Fr. in Aug. 1917.

Uses: Said to be useless and only eaten by goats.

Vern. Name: Bichudi (Br.).

ECLIPTA *L.*

Eclipta erecta *L. Mantiss. II (1771) 286.*—Loc.: Jebri, 147 miles SSW of Kalat, 3,850 ft. (no. 221); Nag (W. Kolwa), about 83 miles E. by N. of Turbat, about 2,300 ft. (no. M 235, M 235 A); Zidi, 15 miles ESE of Khozdar, about 3,600 ft. (no. 355); Gajar, 165 miles SSW of Kalat, 3,450 ft. (no. 221 A); grows in water channels in cultivation. Fl. and fr. in Aug. and Sept. 1917.

Vern. Names: Bikgur (Br.), Murida (Bal.).

ACHILLEA *L.*

Achillea Santolina *L. Sp. Pl. 1,264.*—Loc.: Near Quetta; Kalat, about 6,350 ft. (no. M399, M399 B).—Fl. and fr. in July 1918.

Vern. Name: Known in Kalat under the name of Bo-i-Madaran, which is the name for a Pulicaria.

MATRICARIA *L.*

Matricaria chamomilla *L. Sp. Pl. 1,256.*—Near Quetta.—Fl. and fr. in Aug.

SENECIO *L.*

Senecio coronolifolius *Desf. Atl. II, 273.*—Loc.: Harbud, about 55 miles E. of Panjgur, about 3,700 ft. (no. M 310, M 310 A).—Fl. and fr. in April 1918.

Vern. Name: Zardphul (? Bal.).

TANACETUM *L.*

Tanacetum fruticulosum *Ledeb. Fl. Alt. IV, 58, Ic. t. 38.*—Loc.: Zayaki Jangal 27° 54′ N, 65° 51′ E, about 4,600 ft. (no. M343); Spani, 59 miles S. of Kalat, 5,300 ft. (no. 13E); Harboi, 18 miles ESE of Kalat, 9,000 ft. (no. 13 B) Kuchkan, about 17 miles WSW of Panjgur, about 2,900 ft. (no. M 136, M136 A).—Fl. and fr.: March 1918.

Uses: Excellent sheep fodder. Camels will eat it, but get little profit. Soaked in cold water makes a decoction; very good for colds.

Vern. Name: Drana (Bal.), Drani (all Brahuis, especially Noshki), Butau (Brahuis of Kalat), Jir (Br.).

ARTEMISIA *L.*

Artemisia scoparia *Waldst. and Kit. Descr. et Ic. Pl. Rar. Hung. I (8802) 66, t. 65.*—Loc.: Shambaz Kalat, about 24 miles SSW of Panjgur, about 2,800 ft. (M 176 A); Wad, 27° 20′ N, 66° 20′ E, about 4,000 ft. (no. 1 A); Wahir, about 24 miles S. by W. of Khozdar, about 4,200 ft. (no. 367).—Fr. in Oct. 1917.

Vern. Names: Khisunjir (Br.), Luling (Br.), Jir (Br.), Gwatag (Bal.).

OTHONNOPSIS *J. & S.*

Othonnopsis intermedia *Boiss. Fl. Or. III, 414.*—Loc.: Shandadzai, 72 miles S of Kalat, 5,100 ft. (no. 17 B); Zayaki Jangal, 27° 54′ N, 65° 51′ E, about 4,600 ft. (no. M 344); Harboi, 9,000 ft. (no. 17).

Uses: The plant is used as a poultice for the chest. The leaves are made into a paste with oil. They are then spread on a large chapati and laid on the head of a man suffering from cold or fever. (Hotson).

Vern. Name: Manguli (Br., Bal.).

ECHINOPS *L.*

Echinops echinatus *DC. in Wight Contrib. 24.*—Loc.: Chhuttok, 90 miles S. of Kalat, 4,500 ft. (no. 174).

Echinops vilosissimus *Bge. Syn.* in Bull. Acad. Petrop. *VI 383.*—Loc.: Pishuk, 27° 33′ N, 65° 18′ E, about 5,300 ft. (no. M 342); Panjgur, about 3,100 ft. (no. M 320). Fr. in May 1918.

COUSINIA *Cass.*

Cousinia minuta *Boiss Fl. Or. III, 489.*—Loc.: One mile NE of Panjgur (no. M 170 A).—Fr. in May 1918.

Vern. Name: Kemar (Bal.).

Cousinia multiloba *DC. Prodr. VI, 554.*—Loc.: Surab, 28° 25′ N, 69° 16′ E, about 5,700 ft. (no. M 381).

CENTAUREA *L.*

Centaurea calcitrapa *L. Sp. Pl. 1,297.*—Loc.: Kalat, about 6,350 ft. (no. M 371 B, M 398A); Surab, 28° 29′ N, 66° 16′ E, about 5,700

ft. (no. M371A); Iskalku, 7 miles E. of Kalat, 7,500 ft. (no.11); Surab, 43 miles S. of Kalat 5,750 ft. (no.'115).—Fl. and fr. in June 1918, July and Aug. 1917.

Uses: Eaten only by camels, not by donkeys.

Centaurea picris *Pall. in Willd. III, 2,302.*—Loc.: Kalat, about 6,350 ft. (no. M389A).—Fl. and fr. in July 1918.

Vern Name: Talkh Kah. (Br.).

CICHORIUM *L.*

Cichorium Noeanum *Boiss. Fl. Or. III, 717.*—Loc.: Kalat, about 6,300 ft. (no. M 366B); Surab, 43 miles S. of Kalat, 5,750 ft. (no.12A); Iskalku, 7 miles E of Kalat, 7,500f t. (no. 12); Sitani, 28° 19' N, 66° 5' E, about 5,300 ft. (no. M366); Surab, 28° 29' N, 66° 16' E, about 5,700 ft. (no. M366A). Iskalku is about the highest level at which Hotson has observed this plant. Common near irrigation channels at lower levels.—Fl. and fr. in June and July 1918, Aug. 1917.

Uses: The flowers are soaked in water and the water used for sore legs, and also for a stomach derangement called "dik" (Hotson).

Vern. Names: Kashni, Kashnen, Talka kah (Br.).

KOELPINIA *Pall.*

Koelpinia linearis *Pall. Itin. App. 755.*—Loc.: Sarchib, about 62S. 40′ E, 26° 16' N, about 1,900 ft. (no. M 116, M 116A); near Quetta. —Fl. and fr. in March 1918.

Vern. Name: Zampad (Bal.).

TARAXACUM *Juss.*

Taraxacum officinale *Wigg. Prim. Fl. Hols. 56.*—Loc.: Kalat, about 6,300 ft. (no. M 149D); Surab, 43 miles S. of Kalat, 5,750 ft. (no. 9 C, 9D); Iskalku, 7 miles E. of Kalat, 7,500 ft. (no. 9); Harboi, 18 miles ESE of Kalat, 8,600 ft. (no. 9B); Teghab, 107 miles S. of Kalat, 4,150 ft. (no. 185)—Fl. and fr. in July 1918, Aug. 1917.

Uses: The leaves are eaten raw.

Vern. Names: Halako (Br. Bal.), Pochku, Pochaku, Bahi (Br.), Aghud (Br.).

Taraxacum officinale var. genuinum *Koch Syn. 492.*—Loc.: Surab, 28° 29′ N, 66° 16′ E, about 5,700 ft. (no. M 381).—Fl. and fr. in July 1918.

Vern. Name: Chambar (Br.).

LACTUCA *L.*

Lactuca scariola *L. Sp. Fl. 1119.*—Loc.; Panjgur (no M 102 E); Zidi, 15 miles ESE of Khozdar, about 3,600 ft. (no. 352).—Fl. in May 1918.

Lactuca viminea *J. & C. Presl. Pl. Cech. 160.*—Loc. Surab, 28° 29′ N, 66° 16′ E, about 5,700 ft. (no. M83E).—Fl. and fr. in July 1918.

Vern. Names: Khargoshkah (Bal.), Murubahi (Br.).

Lactuca remotiflora *DC. in Wight Contr. 1,834, 26.*—Loc.: Nokabad in Kulbar Valley, 19 miles NE of Mand, about 1,200 ft. (no. M102).—Fl. in March 1918.

Vern. Name: Pochaku (Bal.).

SONCHUS *L.*

Sonchus oleraceus *L. Sp. Pl. 1753. 794.*—Loc.: Sitani, 28° 19′ N, 66° 5′ E, about 5,300 ft, (no. M149 C). Growing beside irrigation channels.—Fl. and fr. in June 1918.

Vern. Name: Aghud (Br.).

Sonchus asper *Hill Herb. Brit. I (1769) 47.*—Loc.: Near Quetta.—Fl. in August.

Sonchus arvensis *L. Sp. Pl. (Pl. 1753) 1793.*—Loc.: Surab, 43 miles S. 1,753 of Kalat, 5,750 ft. (no. 114).—Fl. and fr. in August 1917.

LAUNAEA *Cass.*

Launaea chondrilloides *Hook. f. Fl. Brit. Ind. III (1881) 415.*—Loc.: Hodal Pass (N. side), about 80 miles S of Panjgur, 2,200—2,500 ft., common nearly everywhere (no. M 114B).

Vern. Names: Mahari, Halaku (Bal.).

Launaea nudicaulis *Hook f. Fl. Brit. Ind. III (1881) 416.*—Loc.: Hushtar Rahi Kaur, 160 miles S of Kalat, about 3,700 ft. (no. 185A); junction of Raghai and Sichk rivers, about 3,600 ft. (no. M305); Hodal Pass (N. Side), 80 miles S. of Panjgur 2,200—2,900 ft, (no. M83B); Rodkan (no. M83D); Chibsar, about 62° 40′ E, 26° 16′ N, about 1,900 ft. (no. M114); Surab 43 miles S. of Kalat, 5,750 ft. (no. 109); Panjgur (no. M 102 I); Rodkan (W. Kolwa), about 85 miles E. of Turbat, about 1,800 ft. (no. M83C); Nagak (W. Kolwa), about 87 miles E. by N. of Turbat, about 2,400 ft. (no. M102B); Sarchib, about 62° 40′ E, 26° 16′ N, about 1,900 ft. (no M115).—Fl. and fr. from March to May 1918.

Vern. Names: Halaco, Marubahi (Br.), Halaku, Mahari halaku, Machi malaku Reki halaku, Khargoshkah, Kakoshonk (Bal.).

Launaea glomerata *Hook. f. in Fl. Brit. Ind. III (1881) 417.*—Loc.: Harbud, about 55 miles E of Panjgur, about 3,700 ft. (no.M115B); junction of Raghai and Sichk rivers, about 3,600 ft. (no. M102D); Panjgur (no. M102G); Garmkan, 1 mile NE of Panjgur, about 3,125 ft. (no. M62A).—Fl. and fr. in April and May, 1918.

Vern. Names: Reki halaku, Machi halako (Bal.).

SCORZONERA *L.*

Scorzonera sp.—Loc.: Panjgur (no. M102H)

Vern. Name: Halaku.

Primulaceae.

ANAGALLIS *L*

Anagallis arvensis *L. Sp. Pl. (1753).* 148.—Loc.: Panjguri, about 3,100 ft. (no. M 151); Nag (W. Kolwa), about 83 miles E. by N. of Turbat, about 2,300 ft.—Fl. and fr. March and April 1918.

Vern. Names: Makui (Sindhi), Makui (Bal.), Boraku (Br.). All these names are doubtful.

Oleaceae.

OLEA *L.*

Olea ouropaea *L. Sp. Pl. I, 11.*—Loc.: Near Ornach, about 3,400 ft. (159B); Halgali Pass (no. M 350A).—Fr. in Sept. 1917.

Vern. Names: Khat, Khat sakar.

Olea cuspidata *Wall. Cat. no. 2817.*—Loc.: Rar Kaur, about 185 miles S. by W. of Kalat, up to 4,000 ft. (no. 159A); Kalgali Pass, about 3,400 ft. (M 350) ; Ornach, about 27° 0′ N, 66° 10′ E.

Uses : These trees are in countless numbers on the Hushtar Rahi Pass, which includes the upper part of the Rar Kaur on the W. or Pelar side and of the Hushtar Rahi Kaur on the E. or Ornach side. I did not notice how low the trees began, probably about 3,000 ft. Those bearing fruit were higher, at the summit of the Pass, nearly 4,000 ft. and on the hills on either side, several hundred feet higher. There are literally tons of berries, and no use is made of them. A few are eaten, but they are not exported, nor is the oil pressed out. Their flavour is pleasant, but scarcely characteristic, sweet at first, with a slightly bitter aftertaste. (Hotson).—Fr. in September 1917.

Vern. Names : Zaitun (Pers. Bal. Br.), Jhak (Bal Br.), Khat (Br.).

Salvadoraceae.

SALVADORA *L.*

Salvadora persica *L. Sp. Pl. (1753) 122.*—Loc. : Near Manguli, 197 miles SSW of Kalat (no. 236); very common below Gwarjak ; Kaur Dat, 10 miles N of Rekin, about 1,900 ft. (no. M 36B); Hills S. of Chambar (Kolwa), 26° 9′ N, 64° 42′ E, about 1,600-2,300 ft. (M 86A).—Fl. in April 1918.

Vern. Names : Kabar (Bal. etc.), Toj (Bal.), Kabad.

Salvadora oleoides *Decne. in Jacq. Voy. Bot. (1844) 140, t. 144.*—Loc. : Hills near Ispikan, about 20 miles NE of Mand, about 1,200-1,500 ft., everywhere the Kabar is yellow with young leaves. (no. M 86).—Fl. in March 1918.

Vern. Name : Kabar (Bal. Br. Sindhi, etc.).

Apocynaceae.

RHAZYA *Dcne.*

Rhazya stricta *Decne. Ann. Sc. Nat. ser. 11, 4, p. 80.*—Loc. : Zahrenkahur, 16 miles N. of Pasni, about 200 ft. (no. M.37) ; Wahir, 25 miles S. by W. of Khozdar, about 4,200 ft. (no. 155A bis).—Fl. in Sept. 1917, Feb. 1918.

Vern. Names: Heshar, Eshar (Makrani Bal.), Heshwark, Heshwark (Br.).

NERIUM *L.*

Nerium odorum *Sol. in Herb. Kew ed. I, 296.*—Loc. : Chuttok, 90 miles S. of Kalat, 4,500 ft. (no. 175) ; Ghulamani Bent, about 21 miles N. of Pasni, about 120 ft. (no. M 50).—Fl. in Feb. 1918, Aug. 1917.

Uses : When eaten fatal to animals.

Vern. Name : Jaur (Bal. Br.)

Asclepiadaceae.

HEMIDEMSUS *R. Br.*

Hemidesmus indicus *R. Br. in Mem. Wern. I (1811) 57.*—Loc. : Near Manguli, 197 miles SSW of Kalat, about 2,450 ft. (no. 245).

Vern. Name : Wal (Bal. Br.).

PERIPLOCA *L.*

Periploca aphylla *Decne. in Jacquem. Voy. Bot.* (*1844*) *109, t. 116.* —Loc.: Taloi Sunt, 11 miles N. of Pasni, about 50 ft. (no. M84); Rari Dan, 170 miles S. by W. of Kalat, 2,300 ft. (no. 158A); Gidardhor, about 80 miles S. of Kalat, about 4,900 ft. (no. 158); E. side of Burida Pass, nearly 140 miles SSW of Kalat, below 4,250 ft. (no. 158 A bis).

Uses: Excellent camel fodder.

Vern. Names: Hum (Br.), Gishtar (Bal.).

GLOSSONEMA *Dcne.*

Glossonema varians *Benth. in Benth. & Hook. f. Gen. Pl. II* (*1876*) *748.*—Loc.: Khozdar, 27° 48′ N, 66° 37′ E, about 4,100 ft. (no. 350); near Sitani, 59 miles S. of Kalat, 5,300 ft. (no. 126, 129); near Ornach, 27° 0′ N, 66° 10′ E, about 3,000 ft. (no. 143 B); Mandi Parak, about 22 miles E. of Chambar (no. M 274); Gar Pass, about 23 miles E. by S. of Panjgur, about 4,200 ft. (no. M 274A).—Fl. in Sept. 1917.

Uses: The follicles are cooked and eaten as vegetable.

Vern. Names: Khuromb, Gavaluk, Gavalok (Br.), Kundu (Bal.), Mashana Galau (Br.).

CALOTROPIS *R. Br.*

Calotropis procera *R. Br. in. Ait. Hort. Kew, ed. 2, II* (*1811*) *78.*—Loc.: Teghab, 107 miles S. of Kalat, 4,150 ft. (no. 189); Las Bela, about 700 ft. (no. 399).— Fl. in Aug. 1917.

Vern. Names: Arakh (Br.), Karg (Bal.).

OXYSTELMA *R. Br.*

Oxystelma esculentum *R. Br. in Mem. Wern. Soc. I* (*1811*) *40.*—Loc.: Gajar, 165 miles SSW of Kalat, 3,450 ft. (no. 230); Korak (Pelar), 180 miles S. by W. of Kalat, about 1,900 ft. (no. 230B).—Fl. in Sept. 1917. Fr. in Sept. 1917.

Vern. Name: Wal (Bal. Br.).

Oxystelma Alpini *Dcne. in DC. Prodr. VIII, 543.*—Loc.: Korak (Pelar) 180 miles S. by W. of Kalat, 1,900 ft. (no. 230 A).—Fl. in Sept. 1917.

Vern. Name: Wal (Bal. Br.).

PENTATROPIS *R. Br.*

Pentatropis cynanchoides *R. Br. in Salt Voy. Abyss.* (*1814*) *App. 64.*—Loc.: Near Kuldan (W. Kolwa) about 85 miles E. by N. of Turbat, about 2,400 ft. (no. M232); Hills S. of Chambar (Kolwa), 26° 9′ N, 64° 42′ E, about 1800—2,200 ft. (no. M232A).—Fl. in April 1918.

Uses: The leaves are soaked in hot milk, then the liquid is gently pressed out and used as a wash for sore eyes.

Vern. Name: Aichk (Bal. Br.).

DAEMIA *R. Br.*

Daemia cordata *R. Br. in Mem. Wern. Soc. 1* (*1809*) *50.*—Loc.: Below Bhani, 131 miles SSW of Kalat, nearly 4,000 ft. (no. 208); Hodal Pass (N. side), 80 miles S. of Panjgur 2,200—2,900 ft. (no. M223); South Parpuki Kaur, 17 miles S. by W. of Panjgur, about 3,400 ft.

(no. M198); Hills S. of Chambar (Kolwa), 26° 9′ N, 64° 42′ E, about 1,800—2,200 ft. (no. M263); Barit Pass, between Pirandar and Nunbara, about 2,000 ft. (no. 266).—Fl. and fr. in April and March 1918.

Uses: The juice is said to be harmful to the skin. I did not observe this. (Hotson).

Vern. Names: Xohi Wal (Bal.), Wal (Br.), Shiter (Bal.).

CYNANCHUM *L.*

Cynanchum Arnottianum *Wight Contrib. 58.*—Loc.: Bizhban Chah (Gichk) about 40 miles E. of Panjgur, about 3,775 ft. (no. M316); Surab, 43 miles S. of Kalat, 5,750 ft. (no. 102); Surab, about 28° 29′ N, 66° 16′ E, about 5,700—5,900 ft., by the sides of irrigation channels (no. M373A); Benn Chah, 21 miles N. of Surab, about 6,200 ft. (no. M373A bis).—Fl. from April to July 1918, in August 1917. Fr. in June 1918.

Uses: The leaves are dried in the shade, not in the sun, and ground to powder: they are then applied to wounds on animals in which there are maggots, and the maggots die. (Hotson).

Vern. Names: Jauri kani, Kuri (Br.), Bhankalink (Bal.).

Cynanchum acutum *L. Sp. Pl. 212.*—Loc.: Panjgur, about 3,100 ft. (no. M232B); below Bhani, 131 miles SSW of Kalat, nearly 4,000 ft. (no. 207); Gajar, 165 miles SSW of Kalat, 3,459 ft. (no. 229) —Fl. in August and September 1917.

Vern. Names: Wal (Br. and Bal.), Aichk (Bal.), Auishk (Br.), Ushkunpan (Br.), Shangrati (Jangli).

PERGULARIA *L.*

Pergularia pallida *Wight & Arn. in Wight Contrib. (1834) 42.*—Loc.: Rar Kaur, about 165 miles S. by W. of Kalat, about 2,600 ft. and higher to near summit, nearly 4,000 ft. (no. 292A); on March 47 to 12 miles N. of Las Bela, 3,500 ft. to 1,000 ft. (no 397); a climber, generally on Tamarisk.—Fl. in Sept. and Oct. 1917. Fr. in Oct. 1917.

Vern. Name: Manja Wali (Bal.).

LEPTADENIA *R. Br.*

Leptadenia Spartium *Wight Contrib. (1834) 48.*— Loc.: Kalgali Kaur, 28° 2′ N, 65° 52′ E, about 5,350 ft. (no. M351); growing among rocks.—Fl. in June 1918.

Vern. Name: Ritachk, Lapar (Br.).

BOUCEROSIA *Wight & Arn.*

Boucerosia Aucheriana *Dcne. in DC. Prodr. VIII, 649.*—Loc.: Near Gajar, 165 miles SSW of Kalat, 3,450 ft. (no. 231); Gwambuk about 50 miles S. by E of Panjgur, about 2,700 ft. (no. M30); Manguli, 26° 45′ N, 65° 21′ E, about 2,600 ft. (no. M30A, M30B).

It has an astringent taste; is eaten raw as a medicine for all sorts of complaints, or cooked as a vegetable. (Hotson).

Vern. Name: Marmot (Br.).

(*To be continued.*)

CURRENT LITERATURE.

Distribution

Becari, O., The Palms of the Philipine Islands, *Philippine Journal of Science XIV No. 3, (March 1919) pp. 295-362,* 3PI.

The author gives a list of the palms of these islands with notes on points of special interest, and descriptions of new species; and prefaces it with a general survey. The number of species at present known is 120, of which about 20 are non-endemic and for the most part belong to the littoral swamps of neighbouring countries. Nearly all the endemic species belong to Malayan genera. The great bulk of the palm flora belong to the genera *Pinanga, Areca, Calamus and Dæmerops.* Of the 36 known species of *Areca* no fewer than 10 are characteristically Philippine ones, and from the occurrance here of closely allied species, and their absence elsewhere, the author considers that *Areca catechu* acquired its specific characters in these islands.

P. F. F.

Evolution

Arber, Agnes, The Law of Loss in Evolution—*a paper read before the Linnaean Society No. 7th, 1918 and, abstracted, in Proc. Linn. Soc. Lond. Oct. 1919. pp. 70-78.*

Mrs. Arber in this paper formulates under the name of the 'Law of Loss' a principle which appears to have operated in the evolution of plants. By this she means the general rule that "a structure or orgen once lost in the course of phylogeny can never be regained; if the organism subsequently has occasion to replace it, it cannot be reproduced, but must be constructed afresh in some different mode." As instances of the working of this Law of Loss, though in the nature of things formal proof cannot be given, she points out that certain water-plants, *Ceratophyllum* and *Utricularia sp.*, are entirely rootless even as seedlings, and since the evidence is all in favour of a terrestrial origin of the Flowering Plants we are driven to the conclusion that these plants have lost the power of producing roots, and that in both the need of an absorbing organ has reasserted itself and has been met, not by the re-establishment of true roots, but by the development of special subterranean shoots which act as roots. Again it seems probable that the Monocotyledons, derived, as we have good reason now for believing, from a dicotyledonous ancestor, have lost the property of forming a true leaf-lamina, so that their leaves consist of base and stalk, or even leaf-base alone; when an attemt is made to produce a compound leaf, it is by a totally different method. As another instance she points out that Flowering Plants are considered to have been derived ultimately from a fern-stock in which the male gamete, in harmony with its aquatic life, is ciliated; but the submerged flowers of present-day phanerogams have merely slightly modified pollen grains which are dependent on currents in the water to find the ovules, the art of producing cilia having been lost. Other instances are the pappus scales of certain Compositæ which there is good reason to believe are hairs, not modified sepals, and Small has given reasons for supposing that this order was derived

from certain of the Lobelideae in which the calyx may have been entirely absent. Yet another instance is the formation of the reserve food (endosperm) of the angiosperm seed out of apparently a second embryo which has been spoilt by the fusion of its nucleus with the polar nucleus, in order to replace the gametophyte, which, reduced in Gymnosperms, had disappeared perhaps with the necessity for limiting the size of the ovules in the closed carpel. The peculiar secondary thickening of the larger Monocotyledons and the polystely of *Gunera* may be explained on the same lines *i.e.* that the original mode of thickenning has been lost, and when in the course of evolution the necessity for a thicker stem again arose, had to be replaced by a different method. On this hypothesis too she suggests that the floral envelope of *Nais* is not a reduced perianth, still less a rudimentary one, but a new structure evolved to take the place of a lost perianth. The new Law is thus in accord with the view that the primitive angiosperm flower was of the type now in the *Ranales*, and is not to be found among the Archichlamydeæ, as assumed in the 'continental' systems of Eichler and Engler, and affords pleasing support for the older system of the *Genera Plantarum* of Bentham and Hooker, in so far at least that in it the *Ranunculaceæ* were placed first, and the *apetalae* last of the Dicotyledons with the Monocotyledons after. Mrs. Arber supports her hypothesis with instances drawn from the evolution of animals, in which the Law of Loss had previously been enunciated in another form. The essay is most interesting and suggestive, and well worth attention. It is in conformity with the idea of the absoluteness of inheritance, towards which so much modern work seems to point.

P. F. F.

Histology

McLean, R. C. Sex and Soma.

This was the title of a communication read at a meeting of the Linnaean Society on November 20th, 1919, with reference to the occurrence of multinucleate cells in higher plants, as described especially by Dr. Arber and Dr. Beer, in a paper which was abstracted in the November issue of this journal, p. 94. The papers has not appeared in print, and the following is taken from the published minutes of the meeting.

"The Author enlarged upon the recently discovered phase of multinucleosis in the developing soma cell of higher plants . . . . and maintained, in opposition to Arber and Beer, that there is evidence of nuclear reunions taking place in the multinuclear cells. He characterized these fusions as modified sexual conjugations consequent upon the long series of vegetable divisions in the lineage of a soma cell, and necessary to avoid the degeneration which experiment shows to be attendant upon prolonged vegetative propagation. The development of the plant body may thus be regarded as embracing two phases of stimulus: firstly, the normal sex stimulus which initiates the period of maximum cell proliferation, and, secondly, this somatic nuclear union, initiating the period of maximum differentiation. Tissue differentiation, it was suggested, may be associated with some process of segregation subsequent to this nuclear fusion . . . It was finally suggested that germinal modifications as well as somatic segregations may be derived from a mechanism of nuclear fractionization and subsequent partial reunion in somatic cells."

P. F. F.

Hepaticae

Evans Alexander W. A Taxonomic Study of Dumortiera *Bulletin of the Torrey Botanical Club, Vol. 46, No. 5, (May 1919).*

The writer gives a historical account of the genus, and fully examines critically the various characters which have been used by various writers on this genus. Stephani recognised three species in his species *Hepaticarum* in 1899 and Campbell published last year the description of a fourth species. The writer however recognises only two species on the basis of the characters drawn from the structural features of the vegetative thallus, and says that the characters "drawn from the size and method of branching of the thalus seem especially unreliable, Those drawn from the female receptacle and the spores are scarcely more satisfactory." The writer has examined a very large number of specimens and gives a full list of synonyms and the places from which the plants came. The following is the key which he gives:—

Upper surface of the thallus smooth or nearly so throughout (although often showing vestigial air chambers). . . . . D. hirsuta.

Upper surface of the thallus with crowded papilliform cells, at least in certain portions (always showing vestigial air chambers). D. nepalensis.

S. R. K.

Allen, E. R., Some Conditions Affecting the Growth of Azotobacter chroococcum. *Annals of the Missouri Botanical Garden, Vol. VI. No. 1, p. I (Feb. 1919).*

The Nitrogen-fixing bacterium *Azotobacter* has since its discovery by Beijerinck in 1901 been the subject of considerable study; and it has been found by many workers that growth in ordinary synthetic culture media is poor, but that an aqueous extract of soil or even tap—instead of distilled water causes a marked improvement. Kzyemieniewski, in 1908, found that the humus was the important constituent of soil, and several suggestions as to the meaning of this have been made. One is that the beneficial result is due to the presence of iron and aluminium-silico-phosphates, but as the optimum quantity of the former lies at 10 mg per 100 cc, and is thus considerably above that which would be required for nutrition, H. Fischer suggested that the role of humus or of the $Fe_2\ O_3$ is that of an oxygen carrier. Bottomly in 1914 suggested that certain bodies, analagous to vitamines and which he called 'auximones', are liberated from peat treated with certain anoerobic bacteria, and that there auximones are the cause of the action of humus in cultures of Azotobacter. In the paper under notice the author describes experiments which point to the need of phosphorus and the absence of all acid in the culture-medium as the chief requirements, and that it is unnecessary to postulate the action of colloidal oxygen carriers or of any special and rare or supposed constituents or products of the soil-humus such as anximones.

P. F. F.

Printed and Published for the Proprietor by W. L. KING at the Methodist Publishing House, Mount Road, Madras.

THE
Journal of Indian Botany.

VOL. I. MARCH, 1920. NOS. 6 & 7.

THE PHYSIOLOGICAL ANATOMY OF THE PLANTS OF THE INDIAN DESERT

BY

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(*Continued from p. 109.*)

ZYGOPHYLLACEAE.

Tribulus terrestris *L.*—Figs. 68, 69, 70. Epidermal cells tabular with outer and inner walls convexly arched outwards and inwards, respectively. Guard-cells elevated. Veins embedded and provided with bundle-sheaths, of thick-walled chlorophyll containing cells. Mesophyll composed of palisade tissue on the adaxia side and of subepidermal aqueous layer and palisade tissue on the abaxial side. Clustered crystals occurring in the leaf and axis. Clothing hairs unicellular on the leaf and axis. Primary cortex forming an aqueous tissue. Wood composite. Wood prosenchyma enclosing the end of the xylem bundles. Pith formed of thick-walled cells.

Tribulus alatus *L.*—Epidermal cells tabular with outer and inner walls convexly arched outwards and inwards respectively. Outer walls superficially granulated. Guard-cells elevated. Mesophyll formed of palisade tissue on the adaxial side and subepidermal aqueous layer and palisade tissue on the abaxial side. Veins embedded and provided with bundle-sheaths of thick-walled chlorenschymatous cells. Clustered crystals in the leaf and axis. Wood composite. Wood parenchyma enclosing the lower ends of the xylem bundles. Pith formed of thin-walled cells.

Seetzenia orientalis *Dcne*—Figs. 71, 72, 73, 74. Epidermal cells tabular. Large water-storing cells intercalated amongst the ordinary epidermal cells. Stomata depressed. Mesophyll formed of

palisade tissue on the adaxial side and of arm-palisade tissue on the abaxial side. Veins not provided with bundle-sheaths. Clustered crystals occurring in the leaf and axis. Assimilatory tissue in the axis formed of chlorenchyma. Wood composite. Pith formed of thin-walled cells and forming occasionally an aqueous tissue.

Zygophyllum simplex *L.* Figs. 75, 76. Epidermal cells polygonal. Guard-cells elevated. Mesophyll composed of a subepidermal composite ring of palisade cells enclosing a massive aqueous tissue surrounding the central vascular bundles. Veins embedded. Peripheral veins numerous, strengthening the aqueous tissue and provided with sheaths of thick-walled cells, the outer ones containing chlorophyll and the inner ones containing clustered crystals. Veins traversing the aqueous tissue. T. S. of the axis kidney-shaped with angles projecting outwards at the grooved surface. Primary cortex forming an aqueous tissue. Wood composite. Pericycle distinctly isobilateral. Pith of thin-walled cells and forming an aqueous tissue. Clustered crystals numerous in the axis.

Fagonia cretica *L.* Figs. 77, 78. Epidermal cells with outer and inner walls convexly arched outwards and inwards. Outer walls superficially granulated. Guard-cells elevated. Mesophyll isobilateral. A group of palisade-like cells faintly green and perhaps with a water-storing function, occurring between the lower epidermis and the vein of the mid-rib. Oxalate of lime not occurring in any form. Veins embedded and provided with bundle-sheaths of thin-walled cells. Assimilatory tissue in the axis formed of palisade cells. Wood composite. Pith formed of thin-walled cells.

Structure of the Axis.—The epidermis consists of tabular cells with outer and inner walls convexly arched outwards and inwards respectively. The lateral walls are usually straight. The outer walls are superficially granulated in *Tribulus alatus*, *Fagonia cretica* and *Zygophyllum simplex*. Large water-storing cells are intercalated amongst the ordinary epidermal cells in Seetzenia orientalis (fig. 71). Epidermal cells are thin-walled; this can be accounted for by the fleshy character of the leaves.

The stomata occur on both the surfaces, though more numerous on the lower; they are surrounded by 3-6 ordinary epidermal cells. Guard-cells are elevated in species of *Tribulus*, *Fagonia cretica Zygophyllum simplex* (fig. 75), so that the front-cavity is on a level with the surface. In *Seetzenia orientalis* (fig. 72), the stomata are depressed and the guard-cells are either in the same plane or in a plane lower than that of the surrounding cells.

The elevated position of the stomata in species of *Tribulus* may be due to a protective covering of hairs and to the subepidamal

aqueous tissue on the lower side, in *F. cretica* to a comparatively extensive ventilating system and to the glandular nature of the plant and in *Zygophyllum simplex* to the abundance of aqueous tissue. The depressed position of the stomata in *S. orientalis* is perhaps due to the absence of aqueous tissue in the mesophyll.

The mesophyll in species of *Tribulus* (fig. 68) is composed of a layer of long palisade cells on the upper side and of a subepidermal layer of polygonal aqueous cells and a layer of short palisade cells on the lower; the middle tissue is represented by the chlorenchymatous cells of the bundle-sheaths. In the cylinderical leaves of *Z. Simplex*, the assimilatory tissue forms a subepidermal composite ring of palisade cells and encloses a massive aqueous tissue of large thin-walled cells, which surrounds the central vascular bundles. In *Seetzenia orientalis* (fig. 71) there is a two-layered palisade tissue on the adaxial side and a two-layered arm-palisade tissue on the abaxial side; the middle tissue consists of thin-walled polygonal cells, some of which contain clustered crystals. The mesophyll in *F. cretica* (fig. 77) is composed of palisade tissue on both the sides with the middle tissue represented by the bundle-sheath cells. *In F. cretica* there occur rounded groups of faintly green palisade-like cells, with perhaps a water-storing function, between the lower epidermis and the vein of the mid-rib. Internal secretory organs do not occur in any of the members.

Oxalate of lime occurs in the form of clustered crystals in the neighbourhood of the veins in species of *Tribulus*, *S. orientalis* and *Z. simplex* in which the inner cells of the sheaths of the peripheral veins mostly contain clustered crystals (fig. 75).

The veins are embedded and are provided with green bundle-sheaths. The sheath-cells are thin-walled and polygonal in *F. cretica*, they are cubical and thick-walled in the other members of the order. The veins are numerous in species of *Tribulus*, *F. cretica* and *Z. simplex*. The abundance of veins corresponds with the abundance of watery contents in the mesophyll. The peripheral veins in *Z. simplex* form a supporting network of veins for the massive aqueous tissue.

Hairy covering is present only on the leaf and axis, in species of *Tribulus*. It consists of simple unicellular hairs which are more numerous on the lower surface of the leaf (figs. 68, 69). External glands are not found on any of the members.

Structure of the Axis.—Epidermis in species of *Tribulus* consists of small thick-walled cells. The epidermal cells in *S. orientalis* are polygonal with outer and inner walls thickened and with lateral walls thin and undulated; there are large cells, perhaps with a water-

storing function, intercalated amongst the ordinary epidermal cells (fig. 73). Epidermal cells in *F. cretica* are tabular with outer walls thickened and cuticularised and with lateral walls thin and straight. Epidermis in *Z. simplex* is composed of polygonal cells with outer walls thickened and papillose. Outer walls are superficially granulated in all members except *T. terrestris*. The stomata are like those on the leaf.

The primary cortex in species of *Tribulus* is characterised by the presence of a layer of subepidermal collenchyma below which occurs cortical parenchyma with a water-storing function. The cortex in *S. orientalis* consists of chlorenchyma and forms an assimilatory tissue; it forms an aqueous tissue strengthened in the projecting angular portions by small stone-cell groups in *Z. simplex*. In *F. cretica* it consists on its outer side of an assimilatory tissue of palisade cells and of an inner portion of an aqueous tissue; it is strengthened by stone-cell groups which can be roughly arranged in three rings, the outermost groups being the largest and almost subepidermal in position and giving a ribbed appearance to the axis.

The pericycle is composed of rhomboidal groups of stone-cells in species of *Tribulus*, *S. orientalis* and *F. cretica*. The stone-cell tissue is extensive and is necessary to strengthen the massive cortical aqueous tissue. The pericycle in *Z. simplex* is composed of stone-cell groups and presents an isobilateral arrangement; the stone-cell tissue along the grooved portion is greatly reduced and consists of isolated stone-cells or of very small groups.

In prostrate axis of species of *Tribulus* and of *S. orientalis* the stone-cell tissue is more extensive along the upper portion of the axis. In spite of the prostrate habit of the axis of *F. cretica* the pericycle does not seem to be much affected except that the stone-cell groups are closer together on the upper side.

The structure of the wood presents an isobilateral appearance in all the members. Wood forms a composite hollow cylinder formed of closely placed xylem bundles. Interfascicular wood prosenchyma is little developed. Wood prosenchyma encloses the lower portion of the xylem bundles in *T. terrestris*, while in *T. alatus* it is replaced by wood parenchyma; this may form a specific difference. Medullary rays are absent except in *F. cretica* where uniseriate rays occur.

Along the upper surface which is more exposed to the sun and climatic factors and which consequently presents greater functional activity, the xylem bundles are larger with vessels larger and more numerous; on the lower side which is protected from the sun the xylem bundles are much smaller and the vessels smaller and less numerous.

The prostrate habit even affects the symmetry of the whole axis in *F. cretica* and *Z. simplex* where the axis is semi-terate and presents a kidney-shaped appearance in T. S., the grooved surface representing the side in contact with the substratum.

Soft bast forms a continuous ring and follows the outline of the wood cylinder. Oxalate of lime is found in the form of clustered crystals in the cortex and pith in the species of *Tribulus* and *T. orientalis*. Pith consists of thick-walled cells in species of *Tribulus* and *F. cretica*; in others it is composed of thin-walled cells. The pith in *S. orientalis* and *Z. simplex* may occasionally form an aqueous tissue.

General Review.—The plants are fleshy and characterised by the plasticity of the tissues as was seen in the different modifications introduced in the prostrate axis. Outer walls of the epidermal cells are not much thickened and are superficially granulated. There is abundance of aqueous tissue in the leaf and axis. Mesophyll is truly isobilateral and shows a distinct tendency to isobilateral symmetry. Hairs, when present, are unicellular. Guard-cells are elevated, so that the front cavity is on a level with the surface, with the exception of *S. orientalis*, where the stomata are depressed. The veins, are embedded and provided in some members with distinct bundle-sheaths. Oxalate of lime-occurs in the form of clustered crystals in the leaf and axis.

The assimilatory tissue is composed either of palisade cells or of chlorenchyma or is absent, in which latter case the primary cortex functions as an aqueous tissue. The pericycle is composed of groups of stone-cells and presents an isobilateral structure. Wood forms a composite hollow cylinder. Medullary rays occur only in *F. cretica* and are uniseriate. The size of the xylem bundles and the size and abundance of vessels vary on the upper and lower surface of the prostrate axis. Soft bast forms a continuous ring and follows the outline of the wood cylinder.

The pith is composed of thick-walled or thin-walled cells. In the latter case the pith may occasionally form an aqueous tissue.

GERANIACEAE.

Monsonia heliotropioides *Boiss.*—Plate X figs. 79, 80, 81. *Leaf only*. Epidermal cells polygonal with outer walls papillose, especially so on the lower surface. Inner and outer walls equally thickened. Stomata occurring on both the surfaces and surrounded by ordinary epidermal cells. Guard-cells elevated. Mesophyll formed of greatly elongated palisade cells on the upper side and of arm-palisade tissue on the lower. Internal glands absent. Clothing hairs unicel-

lular and with muriculate walls. Glandular hairs formed of a short uniseriate stalk and of an obconical unicellular head. Oxalate of lime found in the form of clustered crystals. Leaf many-ribbed. Veins of the ribs vertically transcurrent. Smaller veins embedded.

Structure of the Leaf.—The epidermal cells are polygonal with outer walls papillose much more so on the lower surface. The outer and inner walls are equally thickened. Inner walls are convexly arched inwards, thus coming into close contact with the assimilatory tissue. The lateral walls are thin and undulated. The stomata are more numerous on the lower surface and are accompanied by ordinary epidermal cells. Guard-cells are situated in the plane of the outer epidermal walls; and the front cavity is on a level with the surface.

The hairy covering consists of clothing and glandular hairs; the former are more numerous on the lower surface and the latter more numerous on the upper. The clothing hairs are unicellular and have muriculate walls; the basal portion is conical and is inserted between the epidermal cells (figs. 79, 81). Glandular hairs are formed of a short uriseriate stalk and of an obconical head (figs. 79, 80).

The mesophyll is composed of a layer of very long palisade cells on the adaxial side and of an arm-palisade tissue on the abaxial side. The elongated form of the palisade cells affords protection, against intense light, to the chlorophyll grains. The greatly elongated palisade cells, the development of arm-palisade tissue and the thickening of the outer and inner epidermal walls are distinct proofs of xerophytic characters developed by the plant. Internal secretory organs are not found in the leaf or axis. Oxalate of lime occurs in the form of clustered crystals near the veins.

The leaves are many-ribbed. The ribs are prominent below and grooved above. The veins of the ribs are vertically transcurrent above by colourless parenchyma and below by collenchyma. Smaller veins are embedded. Bundle-sheaths are not found round the veins

SIMARUBACEAE.

Balanites Roxburghii *Planch.*—Figs. 82. 83, 84. Epidermal cells of the leaf and axis tabular. Mesophyill bifacial. Stomata depressed with guard-cells below the plane of the sorrounding cells. Internal glands absent. Oxalate of lime found in the form of solitary and clustered crystals in the leaf and axis. Veins embedded and enclosed in bundle sheaths. Groups of water-storing tracheids occurring at intervals between the veins. Clothing hairs present in the form of short thick-walled unicellular trichomes. Glandular hairs absent. Assimilatory tissue in the axis formed of chlorenchyma. Cortical

parenchyma with numerous water-storing tracheids. Pericycle formed of small groups of stone-cells. Vessels small and few. Interfascicular wood prosenchyma extensive. Medullary rays 1-2 seriate Xylem bundles occurring in the soft bast. Pith characterised by sieve-sclereids.

Structure of the Leaf.—The epidermal cells are tabular with outer and inner walls convexly arched outwards and inwards respectively. The outer walls are thickened. The cuticle is striated. The lateral walls are thin and straight. The stomata are depressed and are more numerous on the lower surface and are surrounded by ordinary epidermal cells. Guard-cells are situated in a plane a little below that of the surrounding cells (figs. 82, 84).

The mesophyll is composed of palisade tissue on the upper side and of spongy on the lower. Internal glands do not occur in the leaf and axis. Oxalate of lime occurs in the leaf in the form of solitary crystals and clustered crystals near the veins of the leaf and in the cortical parenchyma of the axis. The veins are embedded and are provided with green bundle-sheaths; they are protected on the lower side by sclerenchyma. There are numerous groups of water-storing tracheids with pitted markings, occurring at intervals between the veins.

The hairy covering on the leaf and axis consists of thick-walled unicellular straight or bent trichomes (figs. 82, 84.) External glands do not occur on the leaf and axis.

Structure of the Axis.—Epidermis consists of small vertically tabular cells with outer walls greatly thickened and convexly arched outwards. Cuticle is striated. The cortex is composed of arm-palisade tissue on its outer side and of colourless cortical parenchyma on the inner. The cortical parenchyma is distinguished by the presence of sclereids with concentric stratification and radial lamellae.

The pericycle is composed of small groups of stone-cells. The wood forms a composite hollow cylinder. The vessels are small and are arranged in incomplete rows. The interfascicular wood prosenchyma is extensive and is composed of thick-walled cells with small lumina. The medullary rays are 1-2 seriate. A few xylem bundles occur in the soft bast (fig. 83) and form an anomolous structure in the axis.

The pith is characterised by sieve sclereids (fig. 83) and is composed of thick-walled cells.

BURSERACEAE.

Commiphora Mukul *Engl.*—Plate XI, Fig. 85. Epidermal cells of the leaves with innerwalls gelatinised. Stomata present on

both the surfaces. Guard cells elevated. Mesophyll composed of palisade tissue on the upper side and of arm-palisade tissue on the lower, Balsam canals found in the phloem of larger veins and in the soft bast of the axis. Pith cells with tanniniferous contents. Oxalate of lime occurring in the form of solitary, clustered and conglomerate crystals. Larger veins vertically transcurrent below by collenchyma. Hairy covering consisting of a few uniseriate trichomes. Cork sub-epidermal. Assimilatory tissue in the axis formed of chlorenchyma. Vessels large and few. Medullary rays uniseriate and numerous. Sclerenchyma enclosing the lower ends of the xylem bundles. Xylem bundles found in the soft bast. Pith characterised by numerous sieve-sclereids.

Structure of the Leaf.—The epidermal cells are horizontally tabular with inner walls gelatinised and outer walls flat and thickened. They are secondarily divided by thin cross walls beneath which a mucilaginous mass is found. The lateral walls are thin and straight. The stomata are surrounded by ordinary epidermal cells and are more numerous on the lower surface. The guard-cells are elevated and the front cavity is on a level with the surface.

The mesophyll is composed of palisade tissue on the upper side and of arm-palisade tissue on the lower. Some of the palisade cells possess little chlorophyll and break down into cavities in dried material. Small scattered groups of sclerenchyma occur below the lower epidermis.

The internal secretory organs are represented by balsam canals in the phloem of the larger veins and in the soft bast in the axis (fig. 85 B.C.) There are numerous pith cells with tanniniferous contents. Oxalate of lime occurs in the form of solitary crystals near the veins. In the axis solitary as well as clustered and conglomerate crystals are found in cortical parenchyma. The hairy covering consists of a few uniseriate trichomes. External glands do not occur on the leaf and axis.

Structure of the Axis.—The epidermis consists of small tabular cells with outer walls thickened and with lateral walls thin and undulated. The cortex is composed on the outer side of cork and on the inner side of chlorenchyma.

The sclerenchymatous pericycle is not developed. The wood is composite. Vessels are few, large and arranged in incomplete rows. The interfascicular wood prosenchyma is extensive and is formed of cells with thin walls and large lumina. Small groups of sclerenchyma enclose the lower ends of the xylem bundles. The medullary rays are uniseriate and numerous. There are numerous xylem bundles in the soft bast ring giving rise to slightly ribbed appearance to the

axis. The pith is composed of thick-walled cells and is characterised by sieve-sclereids.

CELASTRACEAE.

Gymnosporia montana *Benth.*—Figs. 86, 87. Upper epidermis locally two-layered. Lower epidermis formed of vertically elongated and papillose cells. Mesophyll consisting of palisade tissue on the adaxial side and of arm-palisade tissue on the abaxial side. Internal glands consisting of cells with tanniniferous contents in the leaf and axis. Oxalate of lime not occurring in any form. Veins vertically transcurrent and enclosed in bundle-sheaths. Hairy covering absent. Pericycle composed of groups of stone-cells. Cork subepidermal. Wood prosenchyma formed of cells with thick walls and small lumina. Medullary rays 1-2 seriate. Pith heterogenous.

Structure of the Leaf.—The upper epidermis consists of tabular cells, with inner walls convexly arched inwards; it is locally two-layered by division walls which may be thin or thickened and which are parallel to the surface of the leaf. The lower epidermis consists of polygonal cells which are greatly elongated vertically and are drawn out into papillae (fig. 86). Outer walls are thickened; inner walls are also thickened except in some cases, when the upper epidermal cells are divided by walls parallel to the surface. The lateral walls are thin and straight. The tendency to form a two-layered epidermis as well as the palisade-like elongation of the epidermal cells are adaptations to protect the palisade tissue against insolation as well as to check transpiration by depressing the stomata.

The stomata are numerous only on the lower surface and are surrounded by ordinary epidermal cells. The guard-cells are depressed and the front cavity is placed in a deep depression formed by the palisade-like surrounding cells.

The mesophyll is composed of palisade tissue on the adaxial side and of arm-palisade tissue on the abaxial side. In the mesophyll there are numerous cells with tanniniferous contents. Secretory cells with tanniniferous contents are abundantly found in all tissues of the axis. Tanniniferous contents are found in cortical parenchyma, in cells separating the groups of stone-cells of the pericycle, in numerous cells in the soft bast and in the medullary ray cells which are opposed to the glandular cells between the pericyclic stone-cell groups. Oxalate of lime does not occur in any form in the leaf or axis.

The veins are enclosed in green bundle-sheaths and are vertically transcurrent above and below by colourless thick-walled parenchyma. There are small groups of stone-cells on the lower side of the phloem of larger veins, thus protecting it.

Clothing as well as glandular hairs do not occur on the le and axis. The absence of a hairy covering is compensated for p y by the palisade-like elongated epidermal cells and partly by tL two-layered epidermis.

Structure of the Axis.—The epidermis consists of small ta bular cells with outer walls thickened. The cortex is composed on its o uter side of an extensive cork tissue and on its inner side of glandu lar tissue already described (fig. 87).

The pericycle is composed of closely placed large groups of stone cells separated by secretory cells with tanniniferous contents. The wood is composite (fig. 87). Vessels are fairly large and numerous. Interfascicular wood prosenchyma is composed of thin-walled cells with small lumina. The medullary rays are 1-2 seriate and are numerous, some of their cells holding tanniniferous contents.

The pith is heterogenous and is composed of groups of large elongated cells surrounding small cells (fig. 87).

RHAMNEAE.

Zizyphus jujuba *Lam.*—Fig 88. Epidermis composed of horizontally tabular cells. Upper epidermis of the mid-rib grooved. Uniseriate trichomes more numerous on the lower surface. Secretory cavities not found in cortex. Pericycle formed of stone-cells. Long thin groups of stone-cells present in soft bast.

Zizyphus trinervia *Roxb.*—Figs. 89, 90. Epidermis of the leaf composed of cubical or vertically tabular cells. Upper epidermis of the mid-rib not grooved. Uniseriate trichomes absent on the upper surface. Secretory cavities numerous in the cortex. Long thin groups of stone-cells found in soft bast. Pericycle formed of bast fibres.

Zizyphus rotundifolia *Lam.*— Figs. 91, 92. Epidermis of the leaf formed of cubical and vertically tabular cells. Upper epidermis of the mid-rib grooved. Uniseriate trichomes more numerous on the lower epidermis. Secretory cavities wanting in cortex. Stone-cells absent in soft bast. Pericycle formed of bast fibres.

Zizyphus truncata *Blatt. and Hall.*—Figs. 93, 94. Upper epidermis consisting of cubical and vertically tabular cells. Upper epidermis of the mid-rib not grooved. Uniseriate trichomes absent on the upper surface. Secretory cavities occurring in cortex. Stone-cells wanting in soft bast. Pericycle formed of bast fibres.

Structure of the Leaf:—The epidermis of the two surfaces differ in structure. The upper surface is smooth while the lower one is characterised by alternate ridges and furrows. The epidermal cells of the upper surface are larger and cubical or vertically tabular in all members (figs. 91, 93,) except *Z. jujuba* where they are mostly

horizontally tabular (fig. 88.) The outer walls are thickened and the lateral walls are thin and straight. The inner walls are thin and convexly arched inwards, so as to come into close contact with the assimilatory cells. Some of the upper epidermal cells are filled with yellowish brown contents of the nature of cellulose slime. The epidermal cells of the lower surface are smaller and are horizontally tabular, the outer walls being thickened and the inner and lateral walls thin.

Stomata occur only on the lower surface and are mostly found on the ridges. Guard-cells are situated in the plane of surrounding cells and the front cavity is on a level with the surface.

The mesophyll is composed wholly of palisade cells which are more compact towards the upper surface and are somewhat loosely arranged towards the lower, especially so below the ridged where the stomata are mostly situated (fig. 93.) There are groups of palisade-like cells with faintly yellowish contents, usually above the veins. These perhaps function as water reservoirs. Cells with clustered crystals are numerous near the veins.

Internal glands are represented by groups of palisade-like cells on the upper side of the veins and by rounded cells near the veins, with faintly yellowish contents and functioning perhaps as water-storing tissue. Some of the upper epidermal cells hold faintly yellowish contents of the nature of the cellulose slime.

Secretory receptacles of lysigenous origin occur in the pith of all members and in the inner portion of primary cortex of *Z. trinervia* and *Z. truncata*. The secretory receptacles, as presented in T. S., are numerous and elongated in the former and rounded and few in the latter. The contents seem to be mucilaginous. The secretory receptacles in the pith are large and are lined by a layer of flattened cells resembling an epithelium. Some of the pith cells contain tannin.

Oxalate of lime occurs in the form of numerous clustered crystals in the neighbourhood of the veins.

The veins are embedded and have no distinct bundle-sheaths. There are numerous groups of water-storing tracheids at the terminations of the veins (fig. 93.) The veins of the mid-rib are vertically transcurrent above and below by collenchyma. The mid-rib is prominent below in all species; it is grooved on the upper surface in *Z. jujuba* and *Z. rotundifolia;* in the other species it is not grooved, the upper epidermis being composed of vertically elongated cells with inner and lateral walls thickened.

The epidermal cells of the lower side of the mid-rib and of the upper side, when it is not grooved, are small polygonal cells slight-

ly thickened on all sides, thus adding to the rigidity of collenchyma above and below the veins of the mid-rib.

The hairy covering is composed of uniseriate trichomes (figs. 88, 93.) These are more numerous on the lower surface in *Z. jujuba* and *Z. rotundifolia.* In the other members they seem to occur on the upper surface only. Hairy covering on the axis consists of a few uniseriate trichomes as on the leaf. External glands are not found on leaf or axis.

Structure of the Axis :—The epidermis consists of small polygonal cells thickened on all sides. The primary cortex is characterised by the extensive development of subepidermal cork and by mucilaginous secretory cavities in *Z. trinevia* and *Z. truncata.*

The pericycle is composed of a composite and continous ring of bast fibres in all species except *Z. jujuba,* where it is represented by a composite and continuous ring of stone-cells. There are found long thin groups of stone-cells in the soft bast of *Z. jujuba* and *Z. trinervia.*

The wood forms a composite hollow cylinder in all species. The vessels are large having simple perforations and are arranged almost in complete rows. The interfascicular wood prosenchyma is extensive and is composed of cells with thick walls and small lumina The medullary rays are uniseriate and numerous.

The pith consists of thick-walled cells and is characterised by large mucilaginous secretory cavities. Some of the pith cells hold tanniniferous contents.

General Review :—The species of *Zizyphus* have the same structure in the leaf and axis with certain differences which may be useful in the diagnosis of the species :—

1. Presence or absence of uniseriate trichomes on the upper surface of the leaf.
2. Shape of the upper epidermal cells.
3. Presence or absence of a groove on the upper epidermis of the mid-rib.
4. Pericycle formed of bast fibres or of stone-cells.
5. Presence or absence of stone-cells in soft bast.

SAPINDACEAE

Cardiospermum Halicacabum *L.*—Fig. 95. Epidermal cells tabular with inner walls gelatinised. Stomata occurring on both the surfaces. Mesophyll formed of palisade tissue on the adaxial side and of arm-palisade tissue on the abaxial side. Cells with tanniniferous contents in soft bast and pith. Oxalate of lime found in the leaf and axis. Leaf many-ribbed. Veins vertically transcurrent Clothing hairs unicellular or uniseriate. Glandular hairs formed of

a short uniseriate stalk and of an ovoid curved head. Pericycle formed of a composite ring of stone-cells. Axis ribbed. Ribs strengthened by collenchyma. Assimilatory tissue in the axis formed of chlorenchyma. Wood formed of xylem bundles connected by strands of interfascicular wood prosenchyma. Medullary rays absent. Pith formed of thin walled cells.

Structure of the Leaf:—The epidermis consists of tabular cells which are much larger on the upper surface. The outer walls are a little thickened; the inner walls are gelatinised, and those of the upper epidermis are greatly arched convexly inwards. The lateral walls are very thin and straight. The gelatinisation of the inner walls of the epidermal cells compensates for the hairy covering which is scanty. The stomata are more numerous on the lower surface, and are surrounded by ordinary epidermal calls.

The mesophyll is composed of palisade tissue on the adaxial side and of arm-palisade tissue on the abaxial side. Internal secretory organs do not occur in the leaf. They are represented in the axis by secretory cells with tanniniferous contents in the soft bast and pith. Oxalate of lime occurs in the form of numerous clustered crystals near the veins in the leaf. The clustered crystals occur in a layer of cells outside the pericycle and in the pith of the axis.

The veins are provided with green bundle-sheaths. The leaves are many-ribbed and the veins of the ribs, which are prominent below, are vertically transcurrent above and below by collenchyma. The smaller veins are embedded.

The hairy covering consists of clothing and glandular hairs. The clothing hairs on the leaf are short, thick-walled, unicellular and with a sharp point. The clothing hairs on the axis are longer with muriculate walls; the basal portion is divided by two to three cross-walls. The glandular hairs are formed of a short uniseriate stalk and of a small ovoid head which is curved and is divided by horizontal walls (fig. 95).

Structure of the Axis:—The axis is ribbed. The epidermal cells are small and vertically tabular with outer walls greatly thickened and convexly arched outwards. The primary cortex is formed of chlorenchyma which is bounded internally by a layer of thin-walled colourless cells mostly containing clustered crystals. Strands of collenchyma are developed in the ribs.

The pericycle is formed of a composite ring of stone-cells. The wood is composed of xylem bundles connected together by narrow strands of interfascicular wood prosenchyma formed of cells having thin walls and large lumina. The vessels are very large and have simple perforations. Medullary rays are absent.

The pith consists of thin-walled cells.

MORINGASEAE

Moringa pterygosperma *Gaert.*—Figs. 96, 97. Leaf. Water-storing cells vertically elongated, conspicuous and numerous in upper epidermis. Mesophyll formed of palisade tissue on the adaxial side and of spongy tissue on the abaxial side. Myrosin cells in the form of palisade-like cells and confined to the palisade tissue. Oxalate of lime absent. Veins enclosed in bundle-sheaths. Short unicellular clothing hairs occurring on both surfaces.

Moringa concanensis *Nimmo.*—Fig, 98. *Leaf.* Water-storing cells in upper epidermis few and formed of a little enlarged epidermal cells. Lower epidermal cells with outer walls forming large papillae. Mesophyll composed of rows of palisade cells separated by myrosin cells on the adaxial side, and of armpalisade tissue on the abaxial side. Myrosin cells occurring between the rows of palisade cells as well as on the inner side of arm-palisade tissue. Clustered crystals of oxalate of lime numerous near veins and below lower epidermis. Veins not enclosed in bundle-sheaths but strengthened by arcs of stone-cells on their lower side. Hairs absent.

Structure of the Leaf:—The epidermis differs in structure on the two surfaces. The epidermal cells on the upper surface are tabular with outer and inner walls equally thickened and convexly arched outwards and inwards respectively. There are large water-storing cells, which are numerous and conspicuous in *M. pterygosperma* (fig. 96) intercalated amongst the ordinary epidermal cells, (figs. 96, 98). The epidermal cells on the lower surface are much smaller than those on the upper surface. The outer and inner walls are equally thickened and the latter are curved convexly outwards in the form of papillae which are very large in *M. concanensis* (fig. 96). Lateral walls are thin and straight.

Stomata occur only on the lower surface and are surrounded by ordinary epidermal cells. Guard-cells are situated quite below the plane of the epidermal cells. The front cavity is therefore placed in a pit as deep as the height of the epidermal cells; air in these pits remains moist and transpiration is thus greatly diminished. This kind of contrivance is necessary in leaflets of species of *Moringa* which are not protected by a dense covering of hairs and which, on the other hand, are greatly shaken by wind, thus accelerating transpiration.

The hairy covering consists of a few short, thick-walled unicellular clothing hairs found on both the surfaces of *M. pterygosperma* (fig. 96); it does not occur in *M. concanensis.* External glands are absent.

The mesophyll differs in structure in the two species. In *M. pterygosperma* (fig. 96) it is composed of palisade tissue on the adaxial side and of spongy tissue on the abaxial side. In *M. concanensis* (fig. 98) the palisade tissue occurs on the upper side and is composed of rows of palisade cells separated by greatly elongated myrosin cells; a single layer of arm-palisade cells occurs below the lower epidermis.

Internal secretory organs are abundantly developed, in the mesophyll of *M. concanensis* (fig. 98G.) They are partly composed of greatly elongated tabular cells between the rows of palisade cells and partly of horizontally elongated polygonal cells forming a more or less continuous layer on the inner side of the arm-palisade tissue. Secretory cells in *M. pterygosperma* (fig. 96G) are abundant in the palisade tissue and are repersented by palisade-like cells. Internal secretory cells hold yellowish brown contents and seem to be of the nature of myrosin cells.

Oxalate of lime occurs in the form of numerous clustered crystals near the veins and below the lower epidermis of *M. concanensis*. It is not found in *M. pterygosperma*.

Veins are embedded in both the species. They are enclosed in green bundle-sheaths in *M. pterygosperma ;* they are strengthened by arcs of stone-cells on their lower side in *M. concanensis*.

PAPILLIONACEAE

Heylandia latebrosa *DC.*—Fig. 99. Epidermal cells polygonal. Large water-storing cells intercalated amongst ordinary epidermal cells. Mesophyll bifacial. Veins vertically transcurrent by sclerenchyma. Tannin sacs absent. Clothing hairs in the form of uniseriate trichomes with muriculate walls. External glands absent. Assimilatory tissue in the axis chlorenchymatous. Pericycle formed of bast fibres. Medullary rays uniseriate. Pith formed of thin-walled cells.

Crotalaria Burhia *Ham.*—Figs. 100, 101. Epidermal cells polygonal with lateral walls undulated. Large water-storing cells intercalated amongst ordinary epidermal cells. Mesophyll isobilateral. Veins embedded and enclosed in bundlesheaths. Tannin sacs found near the veins. Clothing hairs in the form of uniseriate trichomes with muriculate walls. External glands absent. Assimilatory tissue in the axis formed of palisade cells. Pericycle formed of stone-cells. Medullary rays uniseriate. Pith formed of thin-walled cells. Cortical vascular bundles present.

(*To be continued.*)

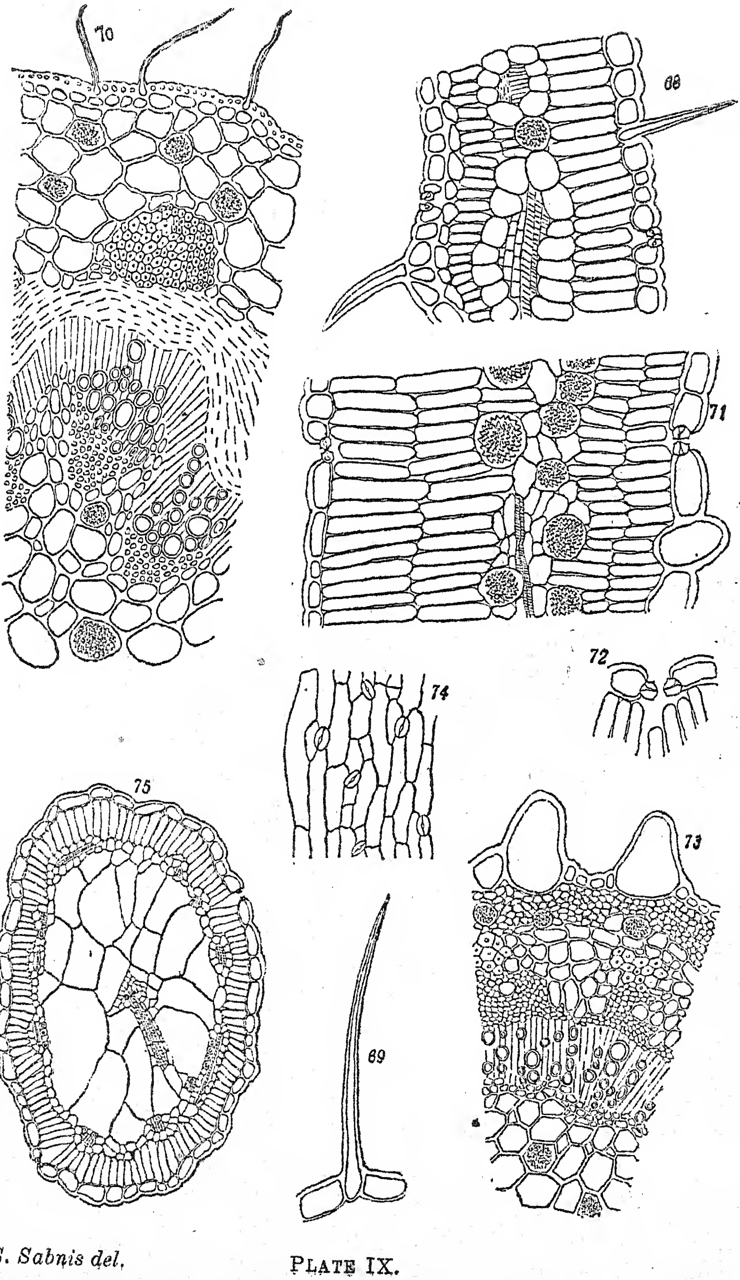
Plate IX

68-70. *Tribulus terrestris.*
68. T. S. of the leaf.
Oc. 1 ; Ob. 3 mm. Ap.
69. Hair on the leaf.
Oc. 1 ; Ob. 3 mm. Ap.
70. T. S. of the axis.
Oc. 3 ; Ob. C.

71-74. *Seetzenia orientalis.*
71. T. S. of the leaf.
Oc. 1 ; Ob. 3 mm. Ap.
72. Stoma on the leaf.
Oc. 4 ; Ob. 3 mm. Ap.
73. T. S. of the axis.
Oc. 4 ; Ob. C.
74.

75. *Zygophyllum simplex.*
T. S. of the leaf.
Oc. 3 ; Ob. A.

N.B.—To get the original dimensions multiply by 1·7.



T. S. Sabnis del.

PLATE IX.

Plate X

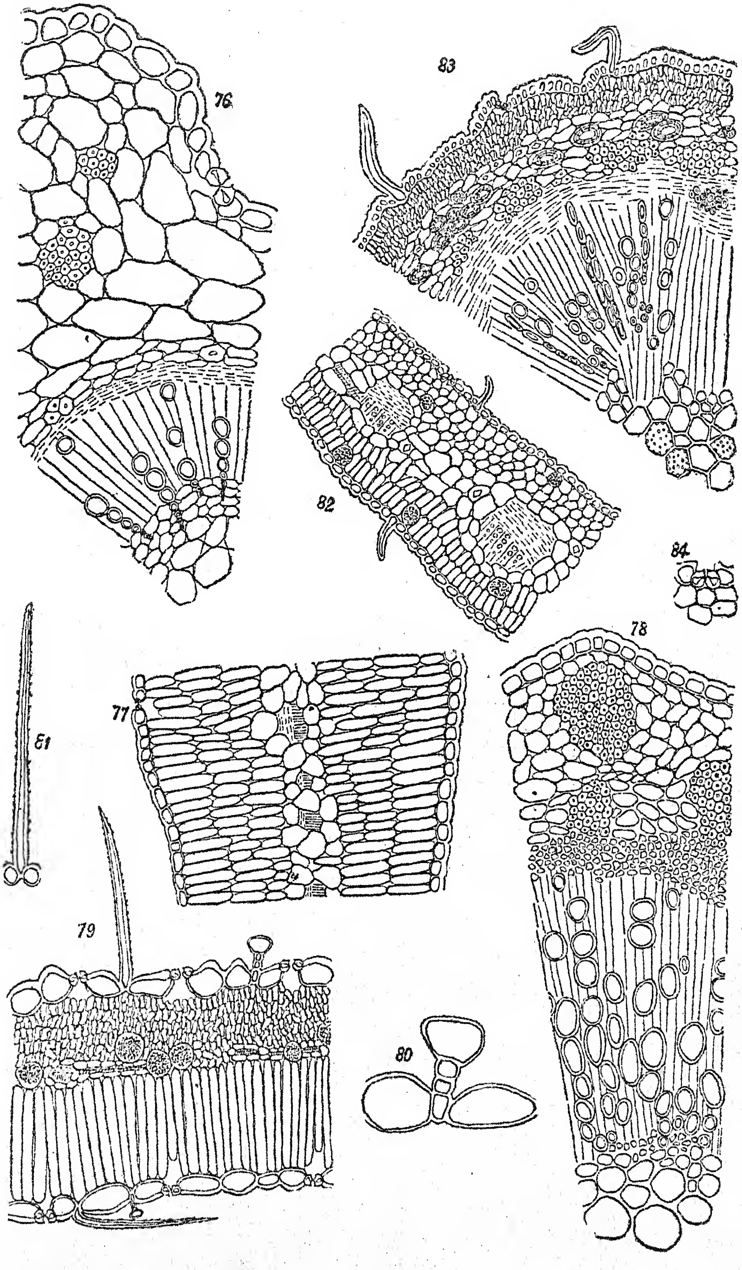
76. *Zygophyllum simplex.*
T. S. of the axis.
Oc. 1 ; Ob. 3 mm. Ap.

77-78. *Fagonia cretica.*
77. T. S of the leaf.
Oc. 2 ; Ob. C.
78. T. S. of the axis.
Oc. 3 ; Ob. C.

79-81. *Monsonia heliotropioides.*
79. T. S. of the leaf.
Oc. 6 Com. : Ob. 8 mm. Ap.
80. Glandular hair on the leaf
Oc. 6; Com. ; Ob. 3 mm. Ap.
81. Hair on the leaf.
Oc. 2 Com. : Ob. 3 mm. Ap.

82-84. *Balanites Roxburghii.*
82. T. S. of the leaf.
Oc. 6 Com. ; Ob. 8 mm. Ap.
83. T. S. of the axis.
Oc. 6 Com. ; Ob. 8mm. Ap.
84. Stoma on the leaf.
Oc. 6 Com. ; Ob. 3 mm. Ap.

N.B.—To get the original dimensions multiply by 1·7.



T. S. Sabnis del.

PLATE X.

Plate XI

85. *Commiphora Mukul.*
T. S. of the axis.
Oc. 4 Com.; Ob. 8 mm. Ap.

86-87. *Gymnosporia montana.*
86. T. S. of the leaf.
Oc. 6 Com.: Ob. 8 mm. Ap.
87. T. S. of the axis.
Oc. 4 Com.; Ob. 8 mm. Ap.

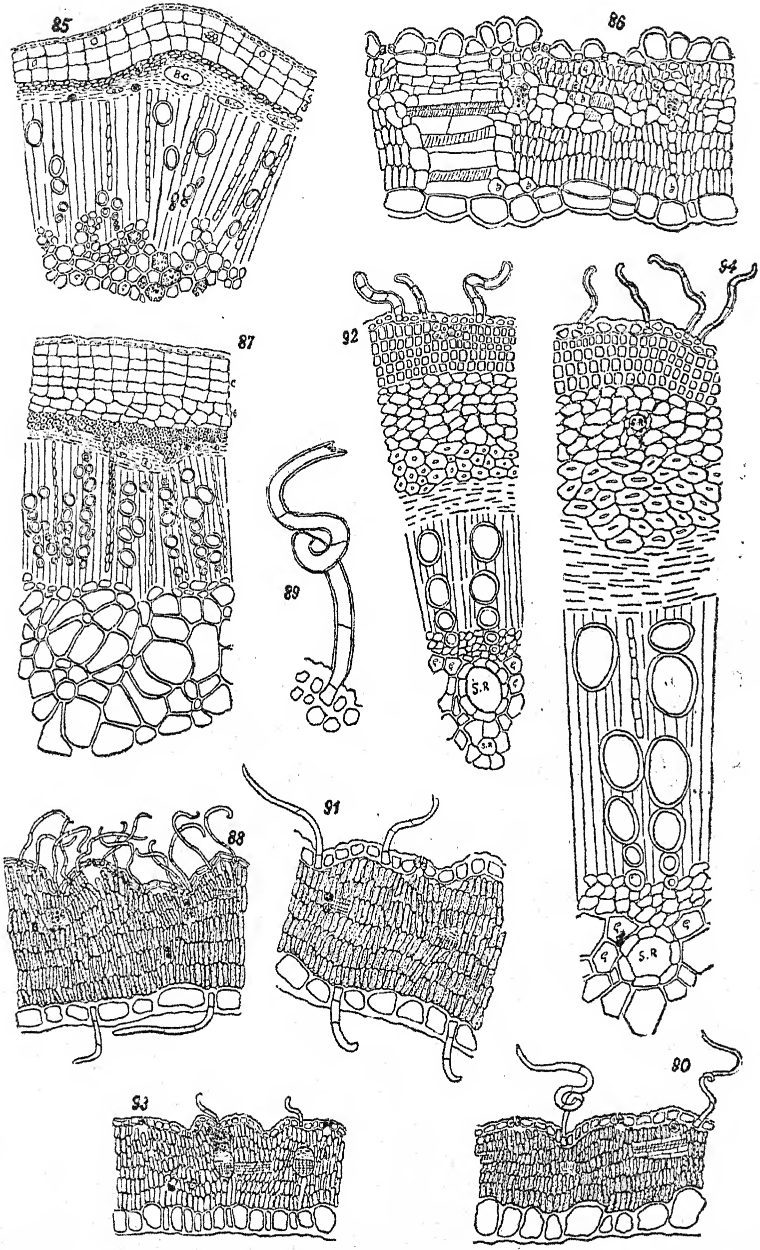
88. *Zizyphus jujuba.*
T. S. of the leaf.
Oc. 3; Ob. C.

89-90. *Zizyphus trinervia.*
89. Hair on the leaf.
Oc. 3; Ob. 7
90 T. S. of the leaf.
Oc 3; Ob. C.

91-92. *Zizyphus rotundifolia.*
91. T. S. of the leaf.
Oc. 3; Ob. C.
92. T. S of the axis.
Oc. 4 Com.; Ob. 8 mm. Ap.

93-94. *Zizyphus truncata.*
93. T. S. of the leaf.
Oc. 1; Ob. C.
94. T. S. of the axis
Oc. 4 Com.; Ob. 3 mm. Ap.

N.B.—To get the original dimensions multiply by 1·7.



T. S. Sabnis del.

PLATE XI.

Plate XII

95. *Cardiospermum Halicacabum.*
   T. S. of the axis.
   Oc. 4 Com.; Ob. 8 mm. Ap.

96-97 *Moringa pterygoeperma.*
   96. T. S. of the ieaf.
   Oc. 6 Com.: Ob. 8 mm, Ap.
   97. Stoma on the leaf.
   Oc. 6 Com.; Ob, 3 mm. Ap

98. *Moringa concanensis.*
   T. S. of the leaf.
   Oc. 6 Com.; Ob. 8 mm. Ap.

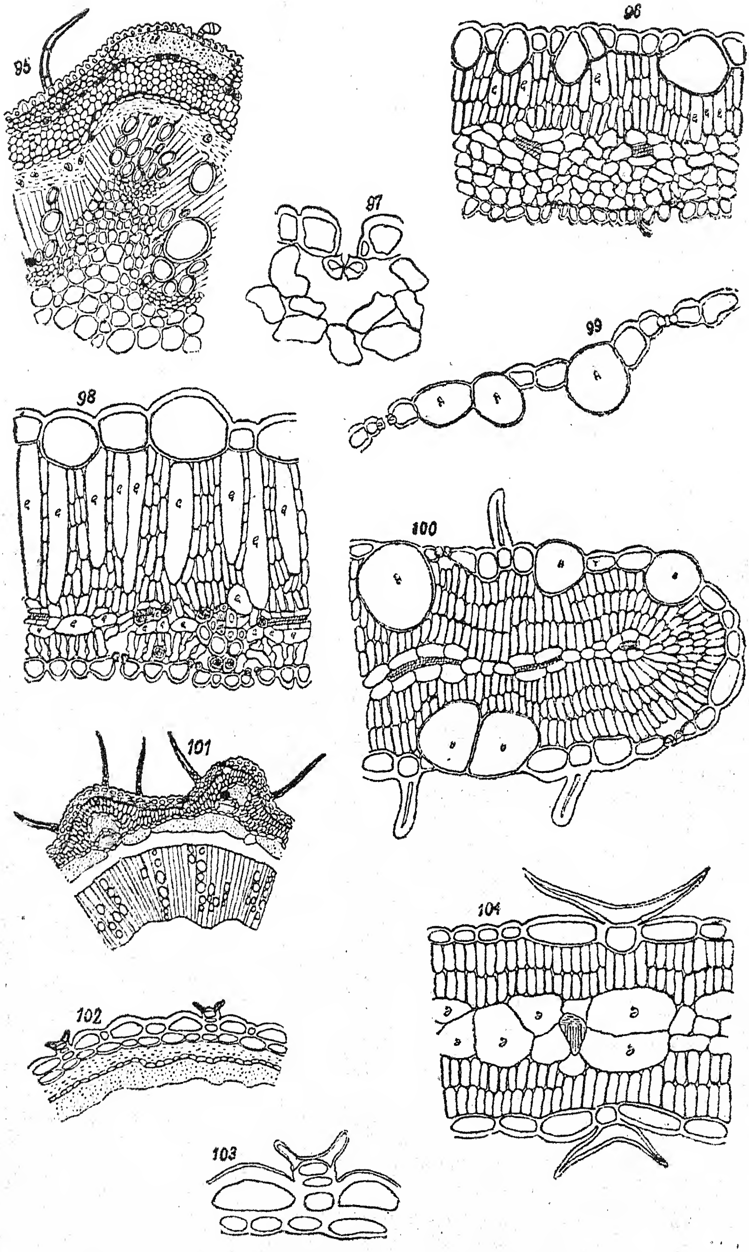
99. *Heylandia latebrosa.*
   T. S. of the leaf showing epidermis.
   Oc. 6 Com.: Ob. 8 mm. Ap.

I00-101. *Crotalaria Burhia.*
   100 T. S. of the leaf.
   Oc. 6 Com.: Ob. 8 mm. Ap.
   I01 T. S. of the axis.
   Oc. 2 com,; Ob. 8 mm. Ap.

102-103 *Crolalaria medicaginea.*
   102. T. S. of the axis.
   Oc. 6 Com.; Ob. 8 mm. Ap.
   103. Hair on the axis.
   Oc. 6 Com.; Ob. 3 mm. Ap.

104. *Indigofera cordifolia.*
   T. S. of the leaf.
   Oc. 4 Com.; Ob. 3 mm. Ap.

N.B.—To get the original dimensions multiply by 1·7.



T. S. Sabnis del.

PLATE XII.

SUSPECTED PARASITISM IN A MOSS.

BY

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The Mosses, though of very common occurrence and of wide distribution, have received little attention from the botanist as regards their physiology of nutrition. In the eighties, there were two opinions about the function of rhizoids in mosses. In 1886, Vaizy [1] showed experimentally that there was no transpiration current in the stem of a moss because no eosin rose into the stem when the cut end was dipped in a solution. Vaizy held that all water absorption was done by the leaves. Later, Haberlandt [2] wrote that, a study of rhizoids in mosses and a consideration of their abundance and extensive branching in the soil, had led him to believe that their function was not merely fixation but was also absorptive. A different aspect of the function of rhizoids is met with in saprophytic mosses, though only very few thorough saprophytes with colourless aerial portions are known. The others have a green aerial portion but their rhizoids penetrate into dead organic substratum. The rhizoids in these are described as being minutely sub-divided and as having the appearance of fungal hyphae with H shaped connections or netted masses.

Observations made by the author on a species of moss, common in Madras, may be of interest, as they show that the rhizoids are, in the early stages, parasitic on colonies of algae, a habit not hitherto suspected in mosses.

The moss grows on walls coated with lime and exposed to the rains during the monsoon weather. Before the rains, the wall has a debris of old dried up mosses on it. After the rains in two or three days, the dried up stumps put forth a few leaves by the growth of the dormant buds at their tips and small green plants dot the surface of the wall. New rhizoids develop immediately below the cluster of leaves and fresh buds are formed in between the plants from the old rhizoids which contain food material stored in them. At the same time, this portion of the wall and also fresh areas surrounding it get coated with a dirty green colour due to the growth

[1] Vaizy, J. Reynolds: *Ann. of Bot. Vol. 1*; *p. 148.*

[2] Haberlandt; *Physiolcgical Plant Anatomy*: *Enq. Ed. 1914, pp. 226—230,* 725.

of blue-green algae. The algae commonly found in these situations, are colonies of Nostoc embedded in soft mucilage, colonies of another blue-green with tough mucilage and filaments of Scytonema. Under the microscope, these appear as masses of algal cells or filaments. The rhizoids of the young plants enter into the algal masses and come into intimate contact with them. In a few more days, the young plants produce a great number of gemmae from the axils of the leaves near the tip of the stem. These get detached and are distributed beyond the area of the wall originally covered by mosses, and get mixed up with the algae growing in these regions. In the outskirts of the older patches, the rhizoids of the young plants grow into the new substratum and give rise to protonema filaments which are covered by masses of blue green algae. Gradually new moss plants appear in these regions and the spreading of the moss on the wall continues. It is a matter of constant observation that no new plants develop in regions of the wall where the algae have not already appeared.

Protonemal Stage.—A microscopic examination of the outskirts of the moss patches, where to all outward appearance no moss plants but only algae are found, show masses of protenema filaments or germinating gemmae. The protenema filaments arise from rhizoids of young plants further up or from hibernating rhizoids of the previous season which had extended so far. The protonemal filaments branch frequently and are mixed up with algal masses and soil particles.

In the preparation of slides, the lime substratum was dissolved with dilute HCl and the sand particles left behind were removed by careful teasing with fine pointed needles. The material for mounting, both in the case of protonema and also in the case of rhizoids of the moss plants in different stages, was prepared in this way, stained and mounted in glycerine.

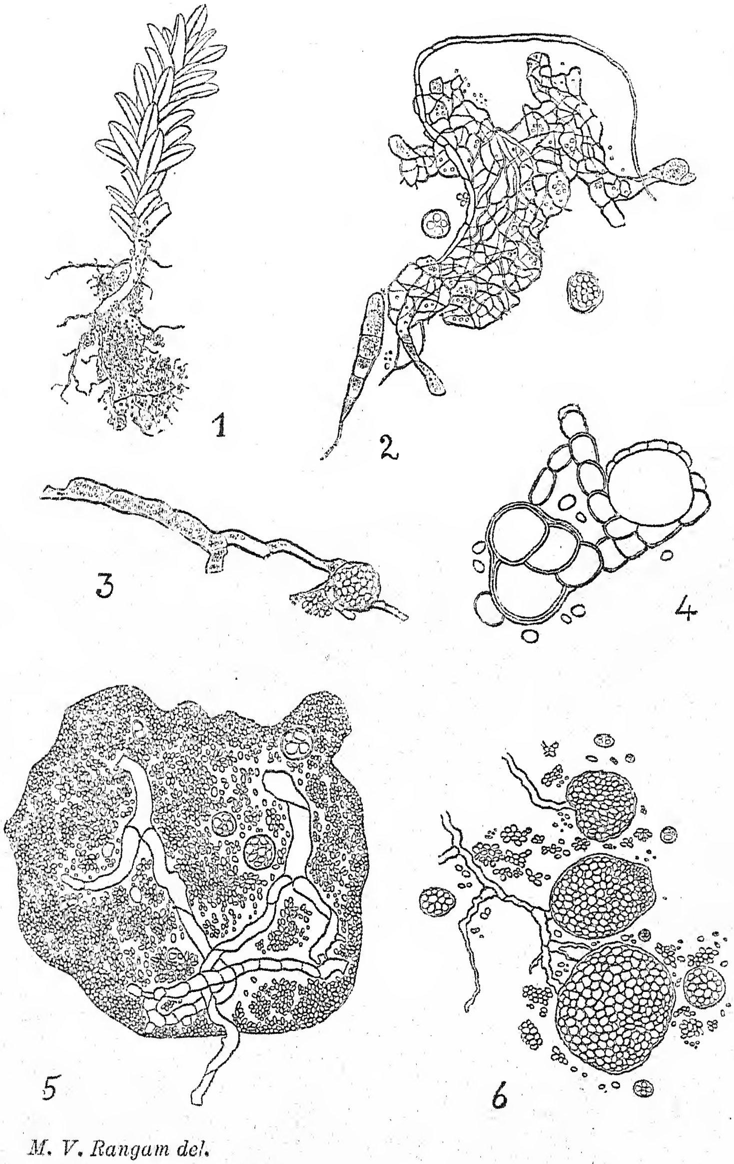
The greater part of the protonema branches were bright green in colour with prominent chloroplasts. But the tips of the filaments in many cases and some of the branches gradually became colourless and finely branched. (Fig. 2.) This colourless portion was always in intimate contact with the algal masses. During teasing, it was often noticed that the green portion was easily detached from the algal masses but they always had their ends broken. Light crushing of the algal mass and differential staining showed that the colourless tips of the protonemal filaments extended into the gelatinous masses of algae and there spread in between the algal cells. In some, where the algae form soft gelatinous masses, the branches had short beaded cells which occupied the centre of the mass. In others, where the algae had tough

mucilage and formed smaller colonies or where they were filamentous, the protonema branches became long and filamentous with long or short cells, and surrounded or intertwined with the algae. During examination of the slides, one is often reminded of the condition in Lichens, with the fungus filaments coiling round big algal cells. This condition is much more striking in the case of the rhizoidal branches of the young moss plants. In the protonemal masses, the similarity is brought out especially, where the cells in contact with the algae are beaded and short as in some lichens. In the mass of algae in the vicinity of the branches, it is common to meet with both decaying and healthy algal cells and those which have partly or fully lost their cell-contents.

Germinating Gemmae.—The Gemmae, when detached from the plant, are club-shaped and 3 or 4 cells long. The first sign of germination is the putting forth of a rhizoidal cell from the basal end. This is followed or in some cases preceded by an oblique division of the apical cell. The rhizoidal cell grows quickly into a filament and extends into the algal masses, in the same manner as that described for the protonema branches though not to the same extent in the early stages. (Fig. 2.)

The Young Moss Plant.—In the young moss plants, when the mud attached to the rhizoids is carefully washed out, it is found that the main rhizoids have dark clots hanging from their ends. These clots, when repeatedly crushed lightly under the cover slip and washed or when treated with dilute HCl, show masses of algae attached to the tips of the main rhizoidal branches. (Fig. 1.) The algae are again of all the three kinds mentioned above, namely, big soft jellies, tough small colonies, and long filaments. These three are the predominant forms, though other forms occur more rarely. The rhizoids on entering the algal masses behave very much in the same way as the tips of protonema branches. In many cases, a much more extensive and minute branching takes place and the resemblance to fungal hyphae coiling round algal cells in Lichens, is very striking. H like connections and net-work formations are more common. In favourable preparations, the encircling of the algal colonies by rhizoidal branches is clearly seen.

Fig. 6 shows a few Nostoc colonies attached to the rhizoidal branches. Fig. 5 shows one of the colonies lightly crushed under the cover glass. The penetration of the branches into the alagal colony is seen. Further examination shows an extremely minute sub-division of the rhizoidal branches and their extension in between the cells of the colonies. In case of colonies with small algal cells, it was not possible to follow the finer ramifications and see exactly in what



M. V. Rangam del.

way the algal cells were attacked by the rhizoidal branches. But usually, either mixed up with the small cells of the colonies or independently, bigger cells of a different species of alga are met with. A few such are shown in Figs. 3 and 4 with the rhizoidal branches, which here consist of short cells, surrounding the algal cells and closely adpressed to them.

But even in these cases no special structures of absorption such as haustoria have been noticed. That haustoria are not a necessary condition for parasitic or symbiotic relationship is shown in the cases of many fungi and also lichens.

The effect of the intimate contact with the algal colonies is seen very clearly. At the beginning, the algal cells are full of protoplasm with bright blue-green colour and have a healthy vigorous appearance. But gradually the colour fades and the contents disappear. Some of the cells of a colony remain vigorous and healthy whereas others are completely or partly decayed. Scytonema filaments, with the portions in contact with the rhizoidal branches in a decaying condition, are quite common. At still later stages, the individual cells of the colonies are not recognisable and only a debris of cell-walls is left. In the case of Scytonema, the thick sheaths devoid of their contents are often met with surrounding the rhizoidal branches.

In plants, which had not been growing for more than a fortnight, large quantities of food material are often found stored up in the rhizoids whose minor branches penetrate into the algal masses. And it is not uncommon to find some of the branches inside the algal masses swollen and full of food material. It is evident that the plants themselves could not have manufactured all this food material by the activity of its green parts, within such a short time and it gives room to a very strong presumption for an external source of the food material. The extraordinary minute branching of the rhizoids, and the intimate contact of the branches with the algal colonies which resembles the behaviour of the fungal hyphae occurring between the algal cells in the Lichens, further strengthens the presumption, that the relation between the moss rhizoids and the algae, is very likely to be one of parasitism of the rhizoids on the algal colonies. My friend Mr. M. O. Parthasarathy Iyengar corraborates my observation and says that in his wanderings in search of algae he had repeatedly noticed that the young moss plants invariably appear only on substrata which are first covered over with blue green algae. He is inclined to believe that the same thing holds good for the common Liverworts which appear immediately after the monsoon in Madras.

As the mosses grow taller, the algae on the substratum disappear

and in the older mosses no algae are found in contact with rhizoids. But it is at the same time interesting to note that the rhizoidal system is also very much reduced in extent by the death of the finer branches. In these, there is a lot of food material found stored in the bigger rhizoidal branches and most of the finer branches are shrivelled up and non-functional. Here and there, a few algal masses are met with on the plants at the axils of the leaves where some dirt has accumilated and into those also rhizoids from the cortical cells of the stem penetrate. But on the whole, in the older plants the amount of algae in their vicinity is very little when compared with the younger plants.

The absence of the algae in the later stages of the life of the moss plant may be accounted for by the fact that the conditions near the substratum are no longer favourable to the growth of algae. The moss plants grow very close to each other and to nearly the height of an inch, so that there is very little light available near the substratum. Higher up on the plants themselves the moisture conditions are not favourable except in special situations. But where they occur, rhizoids penetrate them.

The above observations lead the author to believe that the common moss in Madras is parasitic on the blue green algae of the substratum, when the moss plant is young and also in the protonema stage.

Explanation of Figures on page 209

Fig. 1. Moss plant with algal masses attached to the rhizoids.

Fig. 2. Mass of protonema filaments, some with and some without chloroplasts; ends of filaments broken. One germinating gemma also shown.

Fig. 3. Rhizoidal branch encircling an algal colony.

Fig. 4. Rhizoidal branch with short cells encircling algal cells.

Fig. 5. Nostoc colony crushed showing main rhizoidal branches inside.

Fig. 6. Rhizoidal branches entering Nostoc colonies.

VARIATION IN BOMBAY *STRIGAS.*

BY

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The present paper is a preliminary note embodying scattered observations on variation in species of *Striga* found in the Bombay Presidency.

In the course of the writer's investigation of the flora of Indian grasslands he frequently found *Striga* species. Many of these seemed to be imperfectly described in floras. A closer study of these species was therefore made. It will be convenient to take these one by one.

I. **S. lutea:** A species of wide geographical distribution, given in the floras of Hooker and Cook for India, Trimen for Ceylon, and Mueschler for Egypt. Pearson mentions its occurrence in South Africa where it is a serious pest on maize. In the Bombay Presidency it is a pest of jowar (*Andropogon Sorghum*) and bajri (*Pennisetum typhoideum*).

A. In these floras, in the species keys and descriptions the number of calyx ribs of the species is given as follows:

Hooker: Key, 10-15; Description, 10-ribbed, rarely 15-ribbed.

Cook: Key, 10-15 ribbed, ribs of the calyx most commonly 10; Description "Calyx . . . with one strong hirsute rib running from the base of the calyx to the apex of each tooth, and with 1 (less commonly 2) secondary ribs between them, which terminate at the sinus."

Trimen: Key and description, 10.

Mueschler: Key 10-17 ribbed; 10 ribbed; Description, generally 10 ribbed.

Van Buuren, a graduate of the Poona College of Agriculture, and now in the Ceylon Department of Agriculture, in his paper [1] on Root Parasitism in Some Scrophulariaceae of Western India, states that *S. lutea* is usually 10 to 12 ribbed.

The above descriptions would seem to indicate a certain amount of variation in the number of calyx ribs, and the writer has found this to be the case in even the small number of specimens studied by him personally. 11 ribs are common. One plant gave flowers having respectively 11, 14, and 13 ribs. Another gave 11 and 13, and two others 14 and 13 on each plant. On one plant 15 ribs were found in

(1) Poona Agricultural College Reports No. 1.

one calyx. It is to be noted that additional ribs are never obtained by the increase of the number of main ribs but always by the intercalation of additional secondary ones. If there is only one additional secondary rib that has been always found in an anterior position (fig. 1).

The case of the 15-ribbed plant is shown in fig. 2.

10-ribbed cases were found in many plants collected from Karjat, a station on the line between Bombay and Poona, but few were found among those collected actually at Poona.

B. The colour of the corolla of *S. lutea* is given as follows:

Hooker: "Scarlet, purple, yellow or white."

Cook: "Usually bright yellow, occasionally red or white."

Trimen: "Bright chrome yellow."

Mueschler: "Scarlet, red, yellow or white."

Van Buuren, in an MS. note dated Oct. 21, 1913 says "Corolla in early stages white, becomes a light chrome yellow when older or sometimes chrome yellow."

L. J. Sedgwick, writing to me on 3-9-19 states "The fact that *S. lutea* could be any other colour than yellow had escaped my notice. . . . It is always yellow in the Dharwar Malnad and the Nilgiris." Writing to me later on 15-11-19 the same botanist says "As regards *S. lutea*, Bell swears to having seen the red-flowered form once at Ekambi in Kanara."

The corolla colours observed by the present writer are two (1) a sulphur yellow in plants found in grassland at various places, this colour of corolla has never, up to date, been observed by the writer in plants parasitic on crops; (2) a faintly creamy white, slightly deeper in colour at the throat, in plants parasitic on jowar, bajri, and grasses.

The writer has never seen a red or a purple. There is some probability that Hooker's purple is a description of the bluish tinge which the corolla, and in fact, the whole plant, take on very soon after being plucked.

C. The *anthers* are not described by any of the botanists whose floras have been mentioned. The anthers in *S. lutea* are brownish-yellow in both white and yellow varieties. The colour of the anthers is an aid to distinguishing the white variety from *S. densiflora*. In *S. densiflora* the anthers are bluish-black.

With reference to the yellow variety the writer would quote the following footnote from Van Buuren:

> "Since the publication of this, a specimen which is very similar to *Striga sulphurea* according to the description

given by Cooke was found in the grass lands at Alibag on the banks of a tank. It can hardly deserve rank as a new species, being apparently a small form of *S. lutea.* The corolla is of a deep yellow colour."

The present writer has never seen *S. sulphurea.* L. J. Sedgwick in a letter mentions it as a rare plant found during the monsoon in the Malnad, and says he has specimens.

II. S. densiflora: This is described in all floras as having a 5-ribbed calyx and the writer has found no exceptions to this rule. The 5 primary ribs exist and there are no secondaries.

The corolla is variable in size and shape (fig. 3). The following table gives a comparison of the tube length, anteroposterior and lateral diameters of the flowers of *S. lutea* and *S. densiflora.*

Table.

	Striga lutea.					Striga densiflora.					
mm.										*a.*	*b*
Tube ...	12	12	10	11	13	10	10+3	10+3	8+3	10+3	7+2
Antero-posterior diameter.	10	10	6	6	10	6	8			12	6
Lateral diameter.	10	9	7	7	10	6	10			12	8

a b, These two plants were growing within a foot of each other. All flowers on one plant of uniform type.

The curve in the tube of *S. densiflora* is much more marked than in that of *S. lutea* (fig. 4.) Hence the 10+3, &c. in the tub-length measurements of the former 10 being the measurement below and 3 above the bend. Van Buuren in his MS. note states that the *S. densiflora* tube is "strongly bent above the middle".

As above mentioned, the anthers of *S. densiflora* are bluish black. The writer was at first suspicious that this colour was merely an early appearance of that blueing to which all *Strigas* are subject after plucking. Dissection of young flowers on the living plant however, dispelled this suspicion and showed that bluish-black is the natural colour of the anther.

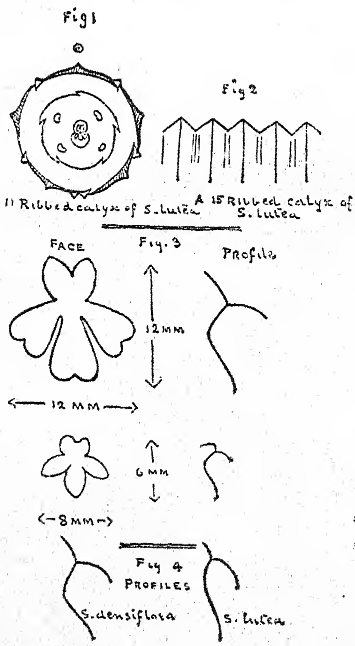
Specimens from different areas sometimes differ. Thus a plant of *S. densiflora* from Chharodi in Gujarat showed close packing of the flowers due to a shortening of the internodes, and increased scabridness with more serration of the leaves when compared with *S. densiflora* collected in Poona.

The writer has found *S. lutea* and *S. densiflora* growing together both in grass and on crops. This is also recorded by Barber and by Van Buuren.

III S. **euphrasiodes**:—The writer was for a long time unable to find this species in any grassland round Poona, although one specimen in the Poona herbarium had been collected at Pashan, a near-by village. At length a very few specimens were found in the area of waste land near the College of Agriculture in a piece of that land adjoining an irrigation distributory. At Chharodi in Gujarat this species was the common one, with occasional *S. densiflora* and no *S. lutea*, while at Tegur in the Dharwar District *S. euphrasiodes* was the only species found.

Van Buuren reported it on roots of grasses of the irrigation channel of the College Farm at Poona, and considered it more hygrophilous than the other species mentioned.

The diagnostic character of this species is the possession of 15 ribs, each main rib having on each side of it a secondary rib which runs right up to the tip of the calyx tooth.



Here again there is some variation in number, all the Chharodi specimens having 16 ribs, the additional rib being, as usual, anterior.

The writer came across one plant pink in the bud and also in the fully expanded corola. Van Buuren states: "At the approach of the dry season some plants which I had under observ-

ation showed a sensitiveness to drought. The leaves took on a purplish-red tinge while even the corolla had many fine streaks of the same colour, doubtless due to anthocyanin pigments."

The corolla length was found to be very variable with reference to the calyx length. No measurements were made.

IV. S. orobanchoides:— This is a well marked holoparasitic species in which the writer has noted no striking variations. It is not common in ordinary grasslands, the few specimens that the writer has seen being from a forest reserve on a hillside near Poona.

Conclusion

The Scrophulariaceœ is an order with apparently a history of variation, if one may judge by the sub-orders, classes and genera into which it is divided. *Striga* itself provides what is apparently a recent mutant. *Strigina*, described by Engler [1] differing from *Striga* in having the two anterior stamens reduced to staminodes. The question arises: Are the two colour forms of *S. lutea* and the plants with different sizes and shapes of corolla in *S. densiflora* to be put in different species? The only answer to this question can be got by growing the plants in pure culture, and up to date the writer has not succeeded in germinating *Striga* seed either by itself or in contact with host roots.

[1] Naturliche Pflanzenfamilien, Nachtrage zum IV. Teil.

NOTE ON THE GEOTROPIC CURVATURE OF THE INFLORESCENE IN EICHHORNIA SPECIOSA *KUNTH* (WATER HYACINTH.)

BY

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There are many striking peculiarities about the Water Hyacinth of which the bending of the inflorescence after flowering appears to be very noteworthy. The bending is seen in several stages but observation at definite intervals extending for a few days brings out certain interesting features which are briefly noticed below.

The inflorescence is an elongated erect spike with about 10-15 lilac or mauve coloured flowers arranged at the top of a long shoot. Flowers are medianly zygomorphic conforming to the formula P 3+3. A 3+3, G (3). There are two sheathing bracteal leaves, inserted one below the other, the lower having a distinct lamina.

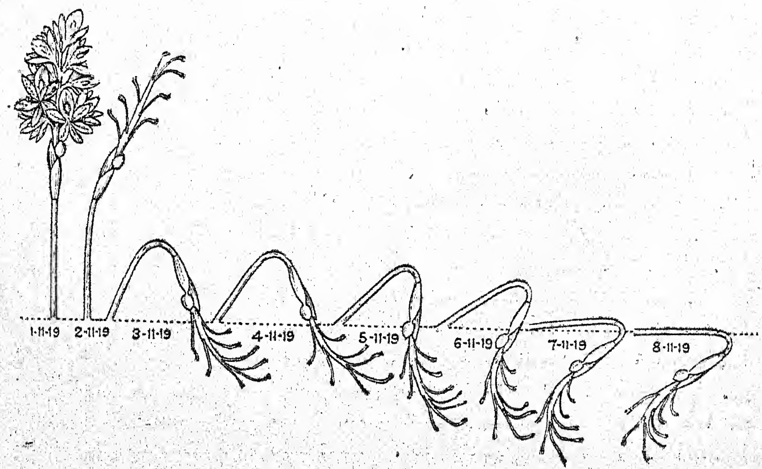
The flowers in each inflorescence open simultaneously at about 8 o'clock in the morning, though occasionally a few may lag behind and open on the next day at the same hour.

With a view to ascertain the exact time of bending of the inflorescence I employed the Ganong's auxograph and placing the plant in position connected the tip of the inflorescence with a thread passing round the larger wheel. By tracing the curve on the cylinder which revolves once in an hour I found on the following morning that the curvature actually commences at about 10 in the night. Plants were also kept separately under observation and the interesting fact was noticed viz., that the closing of the flowers and the bending of the inflorescence occur simultaneously at about 10 P.M.

That the curvature is due to geotropism was proved in the following manner. A plant with flowers just open was fitted in a pot which was loosely packed with wet sponge so as to keep the roots moist. The pot was then fixed to the disc of a klinostat and rotated with the plant held horizontally. The roots were further kept moist by being watered at intervals. Though the flowers had closed as usual there was no curvature of the inflorescence even after three days. Hydrotropism does not play any part for the curvature took place when a plant was adjusted with the inflorescence horizontal and completely immersed in water. This shows that the curvature is the result of geotropism only.

The several stages in the process of bending are shown in the figure below. The actual bending is due to one sided growth at the portion immediately below the insertion of the two sheathing leaves. Examination of this part of the shoot before and after the curvature by marking it with india ink made this clear and it was further noticed that greater growth was as a rule opposite to the bladed sheath so that this was always lower in the curved inflorescence. A rapid bending is seen when the plant is in its best state of growth and the curvature is at two places, one at the base of the shoot and the other just beneath the bracteal leaves referred to above. The bends also appear as loops owing to the basal portion of the shoot being slow of response. The loops were observed in those cases where there was a delay in the development of the topmost flowers. The mutilation of such flowers brought about a similar result as also the complete removal of flowers just opened or of the inflorescence with unopened flowers a little above the insertion of the bracts. The loops were generally characteristic of plants in a poor state of growth. It is interesting to note that the > shaped curvature is reached on the sixth or seventh day of the opening of flowers.

A close study of the phenomenon as explained above shows that we are really dealing with two kinds of geotropic curvatures (1) the *positive geotropism* of the inflorescence resulting in its complete reversal and caused by a curvature beneath the insertion of the bracts, and (2) a *diageotropism* of the lower portion of the flowering shoot which corresponds to the internode of the sympodial vegetative axis and behaves as such



THE FORMATION OF LEAF-BLADDERS IN EICHHORNIA SPECIOSA, *KUNTH*, (WATER HYACINTH)

BY

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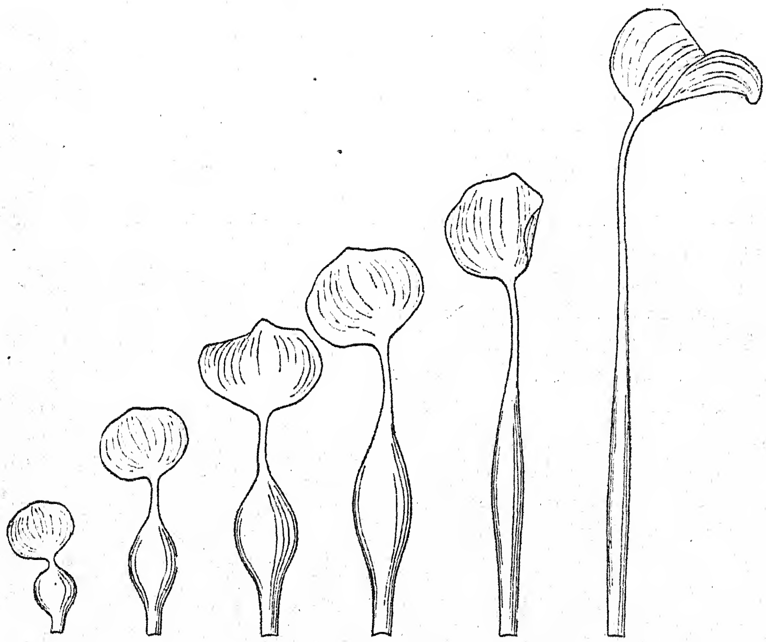
General :—Bladders in plants are comparatively rare and where they occur, they are of doubtful significance in most cases. The best known instances where such structures are conspicuously seen are *Sargassum, Fucus, Nereocystis* among the Fucaceæ, *Trapa* (Onagraceæ) species of *Utricularia*, and *Eichhornia speciosa* (Pontederiaceæ). Except in *Utricularia* where the bladder has been definitely proved to be an insect-catching and insect-preying organ, the functions of the bladders have been generally supposed to be either to serve as floatative or swimming organs or to serve as air reservoirs. In most of the above examples the ecological value has been better known rather than the physiological cause, and the present investigation was undertaken purely from the latter point of view. It applies only to *Eichhornia speciosa*, a study of which was made in the Botanical Laboratory at the Agricultural College and Research Institute, Coimbatore, where the weed attracted notice in connection with the proposed legislation for eradicating it in certain parts of the Madras Presidency.

Though *Eichhornia* is a water plant it thrives in such a variety of situations that observers have differed regarding its exact habitat. Kerner (7) for instance, states that the plants are not fixed in the mud beneath the water by roots but float freely on the surface of the pond. He further characterises *Eichhornia* as a swimming plant distinguishing it from floating plants like *Trapa* which are held fast to the muddy bottom beneath by means of roots. Schonland (10) on the other hand describes it more correctly as either swimming entirely and free on the water or rooting in shallow water in mud, the leaf stalks in the former case becoming strongly swollen and functioning as swimming bladders. Without seriously contradicting these authors it may be stated that plants with and without bladders are found in deep water the determining factor for bladder formation being, as will be seen below, not the depth but a plentiful supply of water that is physiologically available. The plant is also not restricted to any particular surrounding but is at home in ponds, tanks, old wells, ditches, in marshy areas and in fact in any stagnant

or slow moving fresh water of varying depths either as a free floater or rooted in the mud like a swamp plant. It is this indifference with regard to the habitat which makes it not the only troublesome weed that it is but also occasions the formation or not of bladders which are the most striking peculiarity about the plant. An examination of the plant in different surroundings will disclose four principal types, viz., (1) all the leaves of the plant with bladders; (2) all without bladders, (3) outer bladdered and inner bladderless, and (4) outer bladderless and inner bladdered.

Morphology :—In its best development the bladder is a rounded or pear-shaped structure 1 to $1\frac{1}{2}$ in. in diameter, representing the



whole of the leaf stalk and separated from the lamina by a short neck and narrowed at the base. From ten to fifteen leaves become closely aggregated together so as to form a rosette, and from the axils of many of the leaves new shoots arise which end in similar rosettes and originate fresh shoots in their turn. In this way are formed chains of sympodes radiating in all directions and covering a wide expanse of water in a surprisingly short period. Along with these there are also plants in which the bladders attain various stages of development leading to those which show only a slight swelling in the stalk or to its complete disappearance. These do

not produce such a large number of axillary shoots, nor do they exhibit such a pronounced rapidity of growth as is seen in the other plants. The transitional forms are shown in the diagram below.

Physiology :—In order to find out the behaviour of the plant in culture, I had a bladderless plant transferred to a jar containing the necessary salts dissolved in rain water according to Crone's formula. The appearance in a few days of swollen leaf stalks suggested that the chief stimulating factor was water and an examination of both bladdered and bladderless leaves would, it was thought, disclose either some difference in the water content or some sort of constitutional change brought about by the excess or deficiency of water. It is well known that stomata regulate their openings according to the amount of water present in the transpiring organs and thereby prevent too much loss of water from plants. A greater water content will thus keep them open whereas a diminished supply will tend to the closing of the aperture. A highly useful method of ascertaining the width of the stomatal opening is afforded by the work of Iljin (6) on the regulation of stomata. This author and Lloyd have shown that simultaneously with the opening of the stomata, the starch present in the guard cells disappears in some way probably by enzymic activity in the presence of a greater quantity of water and increases again when the water becomes less, as happens for instance during the day when transpiration gets more and more intense. As open stomata are sometimes found even in wetted plants, the appearance of starch does not so much indicate the closure of the stomata as a diminution of the water content in the guard cells and the leaf as a whole. By employing chloral-hydrate-iodine as a delicate test for starch, I examined the stomata of both kinds of leaves at different times during the day. The corresponding youngest leaves were chosen and the results which were confirmed by repeated observations are as follows, the drawings having been made with the help of the Zeichen Apparate.

The conclusions arrived at are :—

(1) that young leaves with bladders or with a tendency to bladder showed very little starch in the guard cells of the stomata which indicates a high-water content in the leaf.

(2) that leaves without bladders always contained more starch which is doubtless a response to the low-water content of the leaf.

It thus appeared possible that the bladders could be induced to form by making the water available to its utmost capacity, and I succeeded in this by growing a plant without bladder in Crone's solution of low concentration, viz., 1 in 1000. Plants were also grown in Sach's solution of normal concentration and in tap-water of the aboratory which is relatively higher in salts. The latter showed no

distension of the stalk whereas the one in Crone's solution responded to the medium and appeared with bladders of the intermediate type already shown above. It was also noticed that the absorption of water from the dilute solution was so enormous that after a warm day when the Temperature suddenly cooled down from 86°F at 3 P.M. to 76°F at 5 P.M. there was copious exudation of water from the apex which was not the case in the other two plants. It may, in this connection, be pointed out that the function of the apical gland appears to be rather to serve as a hydathode than as an absorbing organ as maintained by Goebel (2).

Anatomy:—As an effect of this high-water content notable changes are brought about in the growth of the leaf stalk. The turgidity of the cells is maintained by a high hydrostatic pressure which leads to the dilution of the cell sap as evidenced by the fact that the cells plasmolyse readily with a 1/5 normal solution of potassium nitrate, whereas this concentration is only just enough to overcome the rigidity of the cells in the long stalked leaf. The living cells of the leaf stalk thus become so much gorged with water that a plastic stretching of the cell walls ensues due to superficial growth, and as the cells of both transverse and vertical layers are subjected to this process the stalk assumes a spherical distension comparable to an inflated bladdder, and is filled with numerous polyhedral chambers bounded by layers of thin-walled cells (diaphragms) in an extremely stretched condition. Owing to this plastic stretching from the beginning the intercellular spaces in the diaphragm are considerably reduced and are practically confined to the periphery. Against this may be contrasted the structure of the bladderless stalk. This shows numerous air cavities which are partitioned by diaphragms but these are pierced by intercellular spaces from the earliest stage which points to the absence of any stretching due to turgidity. The intercellular spaces arise by the separation from each other of the walls of the diaphragms cells at several points and the air cavities communicating in this way evidently facilitate rapid diffusion of gas from the aerial organs to the root-system which is badly aerated, being fixed in mud or under other conditions referred to below. In the bladdered leaves, however, the diffusion of air contained in the chambers must be a slow process occurring only through the cell walls as the cavities do not communicate with each other. The presence of needle shaped crystals of calcium oxalate in considerable amounts also suggests the previous formation of oxalic acid which probably maintains a high osmotic pressure owing to the peculiar conditions which lead to the diminished water content. The principal changes in the anatomy are shown below :—

Discussion :—From the whole of the evidence available it seems reasonable to attribute the appearance and disappearance of the bladder to changes in the medium which influence the absorption of water in each case. Firstly, there are plants swimming in deep water which is freely exposed to light and air and in which the maximum absorption is facilitated by a low concentration. The primary effect of such a decrease in the osmotic concentration is, as Livingston (VIII) points out, "to add water to the organism whereas an increase in the concentration has a drying effect". Secondly, there are plants in deep water crowded together so closely that light does not penetrate into it and the medium is also relatively lower in temperature. Thus a difference of 1° C was noticed in the same pond at noon on a sunny day up to 18 inches depth in the midst of the two kinds of plants. The roots in such plants are also covered by the mass of putrefying remains of the older leaves and roots which necessarily produce carbondioxide and various toxins that check rapid absorption of water. Thirdly, when plants are fixed to mud the roots become subject to (1) deficiency of oxygen, (2) coldness of the soil, and (3) higher concentration of water. The greater absorption of water or its check is thus due not to any single factor but to the co-operation of numerous factors which determine the water content of the plant. This water content may be best defined as "a function of the relation that has previously obtained between the rates of water entrance and of water exit," "it being immaterial whether it becomes low through high rates of water loss, or through low rates of water intake" (Livingston, Ed. of Palladin's Plant Physiology), (9). It also appears possible that the very early development of axillary shoots resulting in the formation of the sympodium deprives the original shoots of water and an elongation of the stalk beneath the bladder is rendered impossible. This is well seen in the absence of swellings in the later formed leaves and in the actual elongation of the stalk when the axillary shoots are slow of development.

The question then arises about the real nature of the plant. From the facts stated above it will be clear that the distension of the stalk is not so much an adaptation as a self-adjustment to the medium which aquatics in particular display owing to the extreme plasticity of organs characteristic of them. Goebel (3) who paid some attention to this question in his *Pflänzen biologische Schilderungen* confesses the inadequacy of the explanation on biological grounds, for the bladders are formed above water and the leaf floats with or without it. He noticed the disappearance of the swelling in the later formed leaves though the illustration (4) given in support of this actually resembles one of the transitional stages in which the leaves undergo a partial swelling. A study of the life

history of the plant should of course reveal its real nature. Unfortunately the seeds are difficult to germinate and require special conditions as shown by Crocker (1). But from the appearance of a germ shoot, *Keimpflanze*, figured by Goebel (5) it may safely be concluded that the rosettes of bladdered leaves are merely reversion shoots which are exhibited owing to an innate hereditary tendency present in the plant when the maximum facilities for growth are provided.

In conclusion, I desire to express my sincere thanks to M.R.Ry Rai Bahadur K. Rangachariar Avergal, for suggestive criticism and encouragement during the progress of this work and for ample facilities provided.

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4. **Goebel, K.** Pflanzenbiologische Schilderungen, Vol. I, Taf. IX, Fig 3.
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Explanation of Figures opposite.

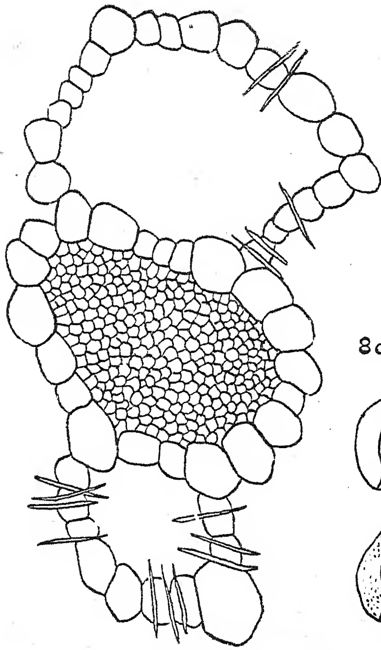
1. Large spaces in the leaf-stalk, bounded by diaphragms, in which lie crystals of Ca. oxalate.

2. Diaphragm cells in stalk without bladder.

3. Stamata in leaf with bladder—upper row.

   Do. without bladder—lower row.

4. Diaphragm cells in stalk with bladder.



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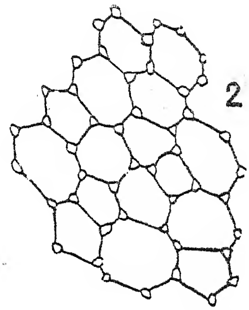

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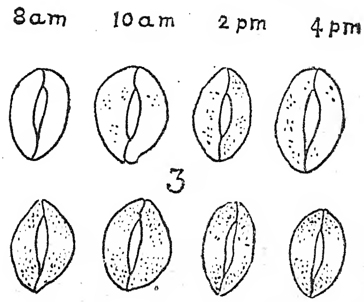

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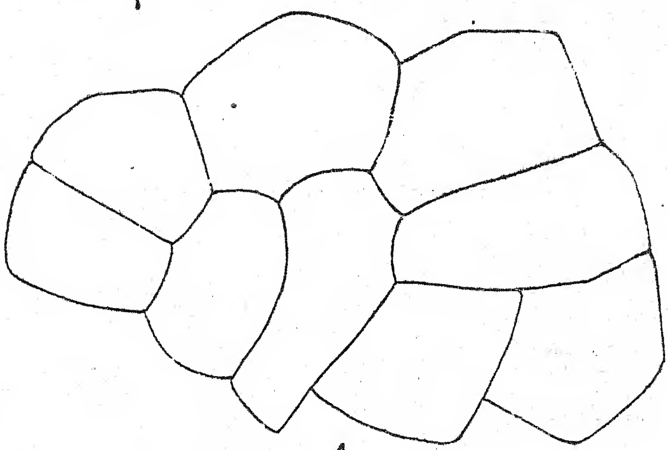

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CONTRIBUTIONS TOWARDS A FLORA OF BALUCHISTAN.

From materials supplied by Col. J. E. B. Hotson, I.A.R.O.

BY

E. BLATTER, S.J., PROF. F. HALLBERG AND C. MCCANN.

St. Xavier's Coll., Bombay.

(*Continued from last issue*)

Gentianaceae

ERYTHRÆA *Renealm.*

Erythraea ramosissima *Pers. Syn. I, 283.*—Loc.: Nagak (W. Kolwa), about 87 miles E. by N. of Turbat, about 2,400 ft. (no. M227, M227A).—Fl. and fr. in April 1918.—

Vern. Name: Puliko (? Bal.).

Boraginaceae.

CORDIA *L.*

Cordia obliqua *Willd. Sp. Pl. I, 1072.*—Loc.: Manguli, 197 miles SSW of Kalat (no. 235); Nag (W. Kolwa), about 83 miles E. by N. of Turbat, about 2,300 ft. (no. M236). Fl. in April 1918.—

Vern. Names: Lewar (Bal.), Jam (Bal.), Livar (Br.).

HELIOTROPIUM *L.*

Heliotropium Eichwaldi *Steud. ex DC. Prodr. IX (1845) 535.*—Loc.: One mile NE of Panjgur (M231A); Turbat, 63° 4′ E, 25° 58′ N, about 600 ft., growing wild in water channels in a garden (no. M54).—Fl. in Feb. and May 1918.—Fr. in May 1918.

Vern. Name: Kapochisk (Bal.).

Heliotropium calcareum *Stocks in Kew Journ. Bot. IV (1852) 174.*—Loc.: Kuldan (W. Kolwa) about 85 miles E. by N. of Turbat, about 2,400 ft. (no, M 245); Zahren Kahur, 16 miles N. of Pasni, about 200 ft. (no. M21A); Rari Dan, 170 miles W. of Kalat, 2,300 ft. (no. 287); Paharmar, 25 miles S. of Wad about 3,650 ft. (no. 376); Hills near Ispikan, about 20 miles NE of Mand, about 1,200-1,500 ft. (no. M91); Mantar Juzhaf, about 40 miles S. of Panjgur, about 3200 ft. (M204); near Kuldan (W. Kolwa), about 85 miles E. by N. of Turbat, about 2400 ft. (no. M231).—Fl. in Feb. (Br.), to April 1918, Oct. 1917.—

Vern. Names: Kapochisk, Nilo, Kodalo (Bal.), Mashna Popat Popat (Br.? Bal.).

Heliotropium paniculatum *R. Br. Prodr. (1810) 494.*—Loc.: Kanoji, 47 miles N. of Las Bela, about 3200 ft. (no. 385); Rari Dan, 170 miles S. by W. of Kalat, 2300 ft. (no. 282). Fl. and fr. in Sept. and Oct. 1917.—

Vern. Name: Nambo (Br.).

Heliotropium rariflorum *Stocks in Kew Journ. Bot. IV (1852)* 174.—Loc.: Rar Kaur, 165 miles S. by W. of Kalat, about 3,500 ft. (no. 298).—Fl. in Sept. 1917.—

Vern. Name: Kolbur (Br.).

Heliotropium undulatum *Vahl Symb. I, 13.*—Loc.: Pusht Kuh (Kharan) about 26 57 N, 56 12 E, about 3500 ft. (no. M301); Garmkan, 1 mile NE of Panjgur, about 3125 ft. (no. (M164); Dukop (no. M11A); Wahir, 25 miles S. by W. of Khozdar, about 4,200 ft. (no. 369).—Fl. and fr. in March and Apr. 1918, Oct. and Dec. 1917.—

Uses: The plant is crushed and soaked in water, and the water is dropped into the eyes if they are sore. (Hotson).

Vern. Names: Sahag Daru (Br.), Shimilo (Bal.).

Heliotropium Aucheri *DC. Prodr. IX, 533,*—Loc.: Kalat, about 3650 ft. (no. M397, 402). Common on roads and dry places.—Fl. and fr. in July 1918.

TRICHODESMA *R. Br.*

Trichodesma africanum *R. Br. Prodr. (1810) 496.*—Loc.: Hills near Ispikan, about 20 miles NE of Mand, about 1,200-1,500 ft. (no. M 100); near Ispikan (no. M 88 A).—Fl. and fr. in March 1918.—

Vern. Name: Charmaing.

ARNEBIA *Forsk.*

Arnebia hispidissima *DC. Prodr. X (1846) 94.*—Loc.: Harboi, 18 miles ESE of Kalat, 9000 ft. (no. 62).

Vern. Name: Mashana Mor Puzho (Br.).

Arnebia cornuta *F. & M. ?*—Loc.: Junction of Raghai and Sichk river.

GASTROCOTYLE *Bunge.*

Gastrocotyle hispida *Bunge in Men. Sav. Etr. Petersb. VII (1847) 405.*—Loc.: Harboi, 18 miles to SE of Kalat, 9,000 ft. (no. 60), Fl.—and Fr. in March 1917.—

Uses: Sheep, etc. eat this (Hoston).

Vern. Name: Mashana Talkha (Br.)

Convolvulaceae.

CONVOLVULUS *L.*

Convolvulus fruticosus *Pall. ex Ledeb. Fl. Ross. II, 734.*—Loc.: Surab, 28° 29′ N, 66° 16′ E., about 5,700 ft. (no. M 382).

Convulvulus microphyllus *Sieb. ex Spreng. Syst. I (1825) 611.*—Loc.: Goshanag, about 16 miles E. of Chambar (Kolwa), about 1780 ft. (no. M 273); Chib, 63° 8′ E, 26° 19′ N, about 1,600 ft., on border of irrigation channels (no. M 127); Pirandar, 205 miles SSW of Kalat, about 1,500 ft. (no. M 255).—Fl. in March and April 1918

Vern. Names: Ispephul. (? Bal.), Pulako (? Bal.).

Convolvulus sp. vicinus C. rhyniospermo *Hochst.*—Loc.: Pirandar, 205 miles SSW of kalat, about 1900 ft.—Fl. in Sept. 1917.—The corolla is half the size of that of C. rhyniospermus; the whole plant is much more hirsute.

Convolvulus spinosus *Burm. f. Fl. Ind. 47, t. 19, fig. 4.*—Loc.: between Mashkai and Pirandar, some 200 miles from Kalat, about 2,500 ft. (no. 250); Nasirabad, 23 miles W. of Turbat, about 400 ft. (no. M58); Kalgali Kaur, N. of Zaiaki Jangar (Kharan), about 4800 ft. (no. M345); Hazarganji (no. 25A); Hazarganji, 27° 28′ N, 66° 12′ E, about 3600 ft. (no. 250 A); near Sitani, 59 miles S.of Kalat, 5,300 ft. (no. 134); Benn Chah, 22 miles N. of Surab, about 6,200 ft. (no. M58C); Zaham, about 52 miles S. of Panjgur, about 2,800 ft. (no. M58A): Jatu Pass, N. side, about 32 miles SSW of Paujgur about 3,300 ft. (no. M200); Panjgur, about 3100 ft. (no. M71), M 58B).—Fl. and fr. in Sept. 1917, March, April and May 1918.

Vern. Names: Delaku (Panjguri Bal., Br.), Dolaku (Panjgurf Bal.), Dolaku (Kachi Bal.), Dohalok (Mandi Bal,). Pulerpit (Bar.,) Girdpit.

Convolvulus arvensis *L. Sp. Pl. (1753) 153.*—Lco.: Harboi, 9,000 ft. (48B); Harboi, 18 miles ESN of Kalat, 9,000 ft. (no. 48); Surab (Jhelawan), 28° 29′ N, 66° 16′ E, about 5,700 ft (no. M380); Surab (no. M380A); Kudabadan, ¼ mile N of Panjgur, about 3,100 ft. (no. 152A); Ornach, 3080 ft (no. 317); Hazarganji, 27° 28′ N, 66° 12′ E, about 3,600 ft. (no. 333); Kalat, about 3650 ft. (no. M380) B, C, and D); Panjgur, about 3,100 ft. (no. M52). Fl. in AUG. and Sept. 1917, March and July 1918. Fr. in Sept. 1917.

Vern. Names: Pechok, Pech, Gul Pech (Br.), Wakarwali, (Sarawan Br.), Mazhgalak (Jhalawan Br.), Ligirk, Likirk (Bal.), Marwal (Sind.).

Convolvulus Rottlerianus *Chois, Cony. Or. in Mem. Soc. Phys. Genycy. VI (1834) 477.*—Loc.: Chib (no. M1 27 A); Wahir (no. 370). Fl. in March 1918, Fl. and fr. in Oct. 1917.

Convolvulus sp., Convolvulo congloyerato vicinus Loc.: Garroki Kaur, 32 miles N. of Pasni, about 350 ft. (no. M 51); near Kaur Dat, about 13 miles N. of Rekin (Kolwa,) about 1950 ft. (M51B); Barit Pass, between Pirandar and Nundara, about 2000 ft. (no. 265); Rekin (Awaran, Kolwa) 26 24 N, 65 12 E, about 1,750 ft. (no. M51A); Hills near Ispikan (M83A); Hills near Ispikan, say 20 miles NE of Mand, about 1200 ft.—Fl. in Sept 1917, February to April 1918.—

Uses: The roots of this plant, when soaked in water, make a strong purgative. (Hotson).

Vern. Names: Ritachk (Bal., Br.), Delaku (Bal.), Khargoshkah (Bal.).

EVOLVULUS *L.*

Evolvulus alsinoides *L. Sp. Pl. ed. 2′:(1762) 392.*—Loc.: Hushtar Rahi Kaur 160 miles S. of Kalat, about 3,700 ft. (no. 308).

CRESSA *L.*

Cressa cretica *L. sp. Pl. (1753) 223.*—Loc.: Hazarganji, 27 28 N, 66 12. E, about 3,600 ft. (no. 330).—Fl. and fr. in Sept. 1917.

Vern. Name: Nambo (Br.).

CUSCUTA *L.*

Cuscuta europaea *L. Sp. Pl. 124.*—Loc.: Surab (Jhalawan), 28 29 N, 66 16 E, about 5,700 ft. (no. M376).—Fl. and fr. in June 1918. Parasitic on Euphorbia sp.

Cuscuta monogyna *Vahl Symb. Bot. II, 32.*—Loc. not given.—Parasitic on Sophora alopecuroides.

BREWERIA *R. Br.*

Breweria latifolia *Benth. ex C. B. Clarke in Hook. f. Fl. Brit. Ind. IV (1,883) 224.*—Loc., Hushtar Rahi Kaur, 160 miles S. of Kalat, about 3,700 ft. (no. 302); Mandi Parag, 22 miles E. of Chambar, about 1.900 ft. (no. M 278) Pirandar, 205 miles SSW of Kalat, ca 1,900 ft. (no. 261) Fl. and fr. in Sept. 1917.

Vern. Name: Puributi (Bai., Br.)

IPOMŒA *L.*

Ipomoea biloba *Forsk. Fl. Aegypt.—Arab. (1,775) 44.*—Loc.: Pasni, 63 28 E, 25 17 N, seashore. (no. M 46 A and M 46). Fl. in Feb. 1918.

Note: This plant was introduced by the Telegraph Dept. from Karachi in an attempt to keep the drifting sand under control. It is now well established (Hotson).

Vern. Name: Softakh? (Brah.), Nangwal (Sind., Bal.)

Ipomoea sagittata *Desf. Atl.I, 177.*—Loc.: Between Kanoji, 47 miles, and Kohanwat, 21 miles N. of Las Bola, 3,500 to 1,400 ft. (no. 393 C and D); Diria Gada river, 32 miles N. of Las Bela, about 2,500 ft. (no. 393 E).

Vern. Name: Wal.

Solanaceae.

SOLANUM *L.*

Solanum nigrum *L. Sp. Pl. (1753 (186.*-Loc.: Khudabadan, ½ mile N. of Panjgur, about 3.100 ft. (no. M 192, M 192 A); Surab, 43 miles S. of kalat, 5,750 ft. (no. M 108).—Fl. and fr. in March 1918. Fl. in Aug. 1917.

Uses: The berries are eaten for pleasure and for pains in the stomach (Hotson).

Vern. Name: Tolangur (Bal., Br.).

Solanum indicum *L. Sp. Pl. (1,753) 187.*—Loc.: Under the Baran Lak, about 28 miles S. of Wad, on the way to Las Bela, about 3,900 ft. (no. 376 A). Fr. in Oct. 1917.

Vern. Name: Kauratrim (Br.).

Solanum incanum *L. Sp. Pl. (1,753) 188.*—Loc.: Near Manguli, 197 miles SSW of Kalat, about 2,450 ft. (no. 240); Pirandar, 205 miles SSW of Kalat about 2,000 ft., and Korak (Pelar) 180 miles S. by W. of Kalat, about 1,900 ft. (no. 240 A); Hushtar Rahi Kaur, 160 miles S. of Kalat, about 3,700 ft. (no. 240B) Fl. and fr. in September 1917.

Uses: The fruit is said to be used as medicine for horses (Hotson).

Vern. Names: Bahir (Bal., Br.), Kaura Trim (Br.)

Solanum xanthocarpum *Schrad. and Wendl. Sert. I (1795) 8, tab. 2.*—Loc.: Baran Lak, about 28 miles S. of Wad, about 3,900 ft. (no. 376). Fl. in Oct. 1917.

Vern. Name: Kaura Trim (Br.).

Solanum gracilipes *Dlne. in Jacq. Voy Bot. (1844) 13, t. 119.*—Loc.: Bar Kaur 165 miles S. by W. of Kalat, about 3,500 ft. (no. 300: Hills S. of Chambar (Kolwa), 26° 9′ N, 64° 42′ E, about 2,300 ft. (no. M 36B); near Chambar (no. M 36D).—Fl. in Sept. 1917, April 1918. Fr. in April 1918.

Vern. Names: Putrunk (Bal.,), Gwangir (Br.).

CAPSICUM. *L.*

Capsicum annum *L.* **var acuminata** *Fingerh. Monogr. Gen. Caps. (1832) 13, t. 2.* Loc.: Korak (Pelar) 180 miles S. by W. of Kalat, 1,900 ft. (no 270. 270A).—Fl. and fr. in Sept. 1917.

Vern.Name: Soren Pirpir (Bal.). The common Chili.

WITHANI *A. Pauq.*

Withania somnifera *Dunal in DC. Prodr. XIII (1852) 453.*—Loc.: Jobri, 147 miles SSW of Kalat, 3,850 ft. (no. 223); Ornach, 27° 0′ N, 66° 10′ E, about 3,080 ft. (no. 319, 319A); Tump 46 miles W. of Turbat, about 600 ft. (no. M 61) Fl. and fr. in Sept. 1917, March 1918.

Vern Names: Kangerishk (Bal.), Lal Gogharo (Br.); Kakink (Bal.)

Withania coagulans *Dunal in DC. Prodr. XIII (1858) 685.*—Loc.: Gidardhor, below Shandadzai, about 80 miles S. of Kalat, about 4,900 ft. (no. 154); Ispikan, 16 miles NE of Mand, about 1050 ft. (no. M77); Mantar Juzhaf, about 40 miles S. of Panjur, about 3200 ft. (no. M 77A); Pishuk, 16 miles NE of Nag (Kharan), about 5200 ft. (no. M77B, M77 C). This is one of the commonest plants in the upper part of the Robhohan valley, beginning some 30-40 miles ENE of Panjgur. It is a some what uncommon plant in Makran, though widely spread.—Fr. in June 1918.

Uses: Besides curdling milk it is said to be used as an intoxicant. The leaves are ground up and used like baang. The berries are crushed and mixed with water and used as a medicine.

Vern. Name: Panerband or Panirband (Bal., Br.).

LYCIUM *L.*

Lycium barbarum *L. Sp. Pl. (1753 192.*—Loc.: Kochau, 122 miles SSW of Kalat, 4,150 ft. (no. 120A); Nal, 27° 41′ N, 66° 13′ E, 3834 ft. (no. 120C); Dokop, 60 miles W. of Turbat, about 700 ft. (no. M10, M10A.); Zahren Kahur 16 miles N. of Pasni, about 200 ft. (no. M 10B); 5 miles N. of Mand about 1,000 ft. (no. M10C); Tapk, about 62° 50′ E, 26° 19′ N, about 1,750 ft. (no. M10 D); Mazhdalu, about 20 miles S. of Panjgur, about 3,000 ft. (no. M10 E); near Kuldan (W. Kolwa), about 85 miles E by N of Turbat, aboht 2,400 ft. (no. M10 F); Ispikan, 16 miles NE of Mand, about 1,050 ft. (no. M 76).—Fl. in Sept. and Dec. 1917. Fr. in March and April 1918, Sept. and Dec. 1917.

Vern. Names: Zirok (Bal.), Kotor (Bal, Br.)

Lycium ruthenicum *Murr. in Comm. Getting. 1779. p. 2.*—Loc.: Hazarganji, 27° 28′ N, 66° 12′ E, about 6,300 ft. (no. 328, and 328A). Mohtaji kand, about 22 miles SW of Panjgur, about 2,800 ft. (no. M 132, M 132A).—Fl. and fr. in March 1918, Sept. 1917.

Vern Name: Jharakh, Jarok (Bal.).

DATURA *L.*

Datura stramonium *L. Sp. Pl .179.*—Loc. : Sitani, 59 miles S. of Kalat, 5,300 ft. (no. 125); Pirumar, 16 miles S. of Khozdar about, 4,100 ft. (no. 125B). Fl. and fr. in Aug. and Sept. 1917.

Vern. Name : Dhatura (Br., etc.).

HYOSCYAMUS *L.*

Hyoscyamus muticus *L. Mant. (1767) 45.*—Loc. : Hodal Pass, N. side, about 80 miles S. of Panjgur, 2,200-2,900 ft. fairly common on the pass. Not yet in flower in April 1918.

Vern. Name : Kohibang (Bal.).

Hyoscyamus pusillus *L. Sp. Pl. 180.*—Loc. : Manguli (Jhalawan) 26° 45′ N, 65° 21′ E, about 2,600 ft. (no. M297, M2M 97A).—Fl. and. fr. in April 1918.

Uses : The seeds are reputed to be acure for tooth-ache.

Vern. Name ; Dantanshan (Bal.).

Scrophulariaceae.

ANTICHARIS *Endl.*

Anticharis glandulosa *Aschers. in Monatsber. Akad. Wiss. Berl. 1866) 880.*—Loc. : Near Manguli, 197 miles SSW of Kalat, about (2,450 ft. (no. 247), Korag (Pelar), 180 miles S. by W. of Kalat, 1,900 ft, (no. 268); Salao, 46 miles N. of Las Bela, about 300 ft. (no. 391A); Kanoji, 47 miles N. of Las Bela, about 3,100 ft. (no. 390).—Fl. and fr. from Sept. to Oct. 1917.

Uses : This plant is dried and used as soap.

Vern. Names : Badro (Br.).

LINARIA *Juss.*

Linaria cabulica *Benth. in DC. Prodr. X, 270.*—Loc. : Bar Kaur, 165 miles S. by. W. of Kalat, about 3,500 ft. (no. 297). Fl. in Sept. 1917.

Vern. Name : Wal (Bal., Br.).

SCHWEINFURTHIA *A. Br.*

Schweinfurthia sphaerocarpa *R. Br.* in Monatsb. Akad. Wiss. Berl. (1866) 875.—Loc. : Pirandar, 205 miles SSW of Kalat, about 1,900 ft. (no. 259); Hills near Ispikan, about 20 miles NE of Mand, about 1,200-1,500 ft. (no. M20A, M20B); Hills S. of Chambar (Kolwa), 26° 9′ N, 64° 42′ E, about 1,900-2,200 ft. (no. M20C); Mitasing, about 17 miles ESE of Panjgur, about 4,000 ft. (no. M20D).—Fl, in Sept. 1917. Fr. in April to May 1918.

Vern. Name : Drohond (Bal., Br.).

LINDENBERGIA *Lehm.*

Lindenbergia urticaefolia *Lehm. Ind. Sem. Hort. Berol. (1829) 1830, 5.*—Loc. : Rar Kaur, about 165 miles S. by W. of Kalat, about 3,200 ft. (no. 306); near Kaoji, 47 miles N. of Las Bela, about 3,200 ft. (no. 378A).—Fl. in Sept. and Oct. 1917.

Vern. Name : Matitao (Br.).

VERONICA *L.*

Veronica anagallis *L. Sp. Pl. (1753) 12.*—Loc.: Sitani (Jhalawan), 28° 19′ N, 66° 5′ E, about 5,300 ft. (no. M364, M364A) growing in moist places on the banks of water channels.—Fl. and fr. in June 1918.

ANARRHINUM *Desf.*

Anarrhinum orientale *Benth. in DC. Prodr. X, 289.*—Loc.: Harboi, 18 miles ESE of Kalat, 9,000 ft. (no. 54).—Uses: Sheep eat this, also goats, etc.

Vern. Name: Nila (Br.).

Anarrhinum *sp.*—Loc.: Pishuk, 27° 33′ N, 66° 18′ E, about 5,300 ft. (no. M341). Fr. inFJune 1918.

LEPTORHABDOS *Schrenk.*

Leptorhabdos virgata *Walp. Rep. III, 387.*—Loc.: Harboi, 18 miles ESE of Kalat, 9,000 ft. (no. 29, 29B, 42). Fl. after rain in Aug. 1917.—Uses: Eaten by sheep.

Vern. Name: Fisun Lathi (Br.).

Orobanchaceae

CISTANCHE *Hoffm. and Link.*

Cistanche tubulosa *Wight Ic. t. 1420, bis.*—Loc: Pirandar, 205 miles SSW of Kalat, about 1,900—2,000 ft. (no. 264, 264A); Las Bela, about 700 ft. (no. 264B). Fl. in Sept. and Oct. 1917.

Vern. Name: Machochik (Br.).

OROBANCHE *L.*

Orobanche aegyptiaca *Pers. Syn. II (1807) 181.*—Loc.: Quetta about 5,550 ft. (no. M403 A,B,C); Residency Garden at Quetta.—Fl, and fr. in July 1918.

Orobanche hirtiflora *Reut.*—Loc.: Kalat, 7,000 ft. (no. 7,); Surab, 43 miles S. of Kalat, 5,750 ft. (no. 7 A).—Fl. in Aug. 1917.—Uses: Eaten by camels and goats.

Vern. Name: Machochik (Br.).

Orobanche oxyloba *Reut.*—Loc.: Baluchistan.

Bignoniaceae.

TECOMELLA *Seem.*

Tecomella undulata *Seem. in Ann. & Mag. Nat. Hist. ser. 3, X (1862) 30.*—Loc.: Kochau (no. 198); Rekin (Awaran, Kolwa) 26° 24′ N, 55° 12′ E, about 1,750 ft. (no. M289): Gwambuk, about 60 miles S by E. of Panjgur, about 2,700 ft. (no. M23, M24D): about 6 miles E. of Mand, 62° 3′ E, 26° 7′ N, about 850 ft. (no. M23A, M23B).

One little nala was covered with these bushes in full flower, a most gorgeous sight. Though we saw many of these bushes later on we saw no more flowers. The colour is a brilliant, almost orange yellow. Fl. in March 1918, Bagai Daf (Mantar), about 42 miles S. of Panjgur, about 3,100 ft. (no. M23C), a row of these trees along a

cliff fall, just freshly green in April 1918. Only a few flowers Kavneh Kalat (Gichk), about 45 miles E. of Panjgur, about 3,750 ft. (no. M23E), groves of this tree in flower in April 1918. .Two varieties are recognized: one is yellow with some reddish markings, the other yellow inside, reddish round the edges; Siahen Damb (Gichk), about 36 miles E. by S. of Panjgur, about 3,800 ft. (no. M23G), this is a pure yellow flower, April 1918; Siahen Damb (no. M23I), a very deep red flower, April 1918; Siahen Damb (M23H), a red flower not so dark as the last, which grew on the same branch, these have no trace of the yellow centre, which is very commonly seen. It is almost leafless in February, in full flower in April; in Turkestan it flowers in November and December.

Uses: The wood of the yellow variety is hard, much used, that of the reddish variety is soft and of little value. The flowers are boiled and the water drunk (in cup fulls) for drieness of the liver and swollen belly.

Vern. Name: Parpuk (Bal., Br.)

Acanthaceae

RUELLIA *L.*

Ruellia patula *Jacq. Misc. Bot. II (1781) 358.*—Loc.: Near Ornach, about 3,300 ft. (no. 316); Hushtar Rahi Kaur, 160 miles S. of Kalat, about 3,700 ft. (no. 307).-Fl. and fr. in Sept. 1917.

BLEPHARIS *Juss.*

Blepharis edulis Pers *Syn. II, 108.*—Loc.: Between Mashkai and Pirandar valleys, 200 miles from Kalat, about, 2,500 ft. (no. 249); Kanoji, 47 miles N. of Las Bela. about 3,200 ft (no. 387).; Ben Chah, 25 miles N. of Surab (Jhalawan), about 6,200 ft. (no. M 387); near Kuldan (W. Kolwa), about 85 miles E. by N. of Turbat, about 2,400 ft. (no. M96A); near Bazdad, 25 miles E. of Chambar (Kolwa), about 1,850 ft. (no. M 96B).—.Fr. in Sept. 1917, April 1918.

Uses: Said to be used as a green manure at the roots of vines.

Vern. Name: Sagi Dantan (Bal.).

BARLERIA *L.*

Barleria acanthoides *Vahl Symb. I, 47.*—Loc.: Hills S. of Chambal (Kolwa) 26° 9′ N, 64° 42′ E, about 2,200 ft. (no. M257).—Fr. in Apri 1918.

PERISTROPHE *Nees.*

Peristrophe bicalyculata *Nees in Vahl Pl. As. Rar. III, 113.*—Loc.: Dalna Khor, 29 miles N. of Las Bela, about 2,000 ft (no. 395).

Verbenaceae.

LIPPIA *L.*

Lippia nodiflora *Rich in Michx. Fl. Bor. Am. II. 15.*—Loc: Panjgur (M329H); Khozdar, 27° 48′ N, 66° 37′ E, about 4,100 ft. (no. 342).—Fl. in Sept. 1917 and May 1918.

Vern. Name: Gandago (Bal.).

VERBENA *L.*

Verbena officinalis *L. Sp. Pl. (1753) 20.*—Loc.: Jebri, 147 miles SSW of Kalat, 3,850 ft. (no. 225); Kozdar, 27° 48′ N, 66° 37′ E, about 4,100 ft. (no. 346).—Fl. and fr. in August and Sept. 1917.
Vern. Name: Sandol (Bal.).

VITEX *L.*

Vitex agnus-castus *L. Sp. Pl. 638.*—Loc.: Gidar Dhor, below Shahdadzai, about 80 miles S. of Kalat, about 4,900 ft. (no. 156) Garmkan, 1 mile NE of Panjgur, about 3,125 ft. (no. M 166); Panjgur, (no. M 166A). Fl. in May 1918.
Vern. Name: Gwanik (Bal., Br.).

Labiatae

OCIMUM *L.*

Ocimum basilicum *L. L. Sp, Pl. (1753) 597.*—Loc.: Korak (Pelar), 180 miles S. by W. of Kalat, 1,900 ft. (no 269). Fl. in Sept. 1917.
Vern. Name: Niazpu (Br.)

ORTHOSIPHON *Benth.*

Orthosi phonpallidus *Royle, MSS ex Benth. in Hook. Bot. Misc. III (1833)* 370.—Loc.: Baran Lak, 29 miles S. of Wad, about 4,100 ft. (no. 381). Fr. in Oct. 1917.

MENTHA *L.*

Mentha sylvestris *L. Sp. Pl. ed. 2, 804.*—Loc.: Kalat, 7,000 ft. (no. 6; M 359A) Sitani (Gidar, Jhalawan), 28° 19′ N, 66° 5′ E, about 5,300 ft. (no. M359). Fl. and fr. in June to Aug. 1918.
Vern. Name: Purchink (Br., Bal.)

SATUREIA *L.*

Satureia montana *L. Sp. Pl. 568.*—Loc.: Under Harboi 18 miles ESE of Kalat 8,300 to 9,000 ft. (no. 28). Fl. in Aug. 1917.
Vern. Name: Purchink (Br.).

Satureia *sp.*—Loc.: Spring on Harboi, 18 miles ESE of Kalat, 8,600 ft. (no. 64). Fl. in Aug. 1917.
Vern. Name: Mashana Sosingi (Br.).

PEROWSKIA *Karel.*

Perowskia abrotanoides *Kiril. in Bull. Mosq. (1841) 15, t. 1.*—Loc.: Harboi 18 miles ESE of Kalat, 9,000 ft. (no. 14B); N. side of Kalgali Pass (Jhalawan), about 28° 11′ N, 66° 1′ E, about 8,200 ft. (no. M235); Iskalku, 7 miles E of Kalat, 7,500 ft. (no. 14A), has a very wide area from about 6,000 ft. upwards, abundant in the 'kucha' pasture.—Fl. in June to Aug. 1917.

Uses: The flowers are soaked and the body of a man suffering from fever washed in the water; very cooling.
Vern. Name: Gwari drani (Br.).

SALVIA *L.*

Salvia aegyptiaca *L. Sp. Pl. (1753) 23.*—Loc.: Near Ornach, about 3,300 ft. (no. 313). Fl. and fr. in Sept. 1917.

Vern. Name: Kohi Maur (Bal.).

Salvia macilenta *Boiss. Diagn. ser. 1, 13.*—Loc.: Hills near Ispikan, about 20 miles NE of Mand, about 1,200-1,500 ft. (no. M85, M85A). Fl. and fr. in March 1918.

Vern. Name: Bo-i-Madaran (Bal.)

Salvia santolinaefolia *Boiss. Diagn. ser. 1. V. 13.*—Loc.: Zahren Kahur, 16 miles N of Pasni, about 200 ft. (no. M39); Ispikan 16 miles NE of Mand about 1,050 ft. (no. M39A); Chib (Buleda), 36° 8′ E, 26° 19′ N, about 1,600 ft. (no. M39C); Hills S. of Chambar (Kolwa), 26° 9′ N, 64° 42′ E, about 2,200 ft. (no. M258); Pangur (no. M85C); Manguli (Jhalawan), 26° 45′ N, 65° 21′ E, about 2,600 ft. (no. M90B): Hushtar Rahi Kaur. 160 miles S. of Kalat, about 3,700 ft. (no. M220A); Tapk, about 62° 50′ E, 26° 19′ N, about 1,750 ft. (no. M121); Siahen Damb (Jichk), about 36 miles E by S. of Pangjur, about 3,800 ft. (no. M317, M317A).—Fl. and fr. from Feb. to May 1918, Sept. 1917.

Vern. Names: Shwanko, Shwanago, Bo-i-Madaran, Bodpu (Bal.), Puzhu, Morpuzho, Maur, (Bal. Br.).

Salvia sclarea *L. Sp. Pl. 27.*—Loc.: Kalat, about 6,350 ft. (no. M392, M392A M392B); Kochau, 120 miles SW of Kalat, 4,150 ft. (no. 199). Hodal Pass (N. side) about 80 mile S. of Panjgur, 2,200-2,900 ft. (no. M218), fairly common on the Pass; Near Sitani, 59 Miles S. of Kalat, 5,300 ft. (no. 137); near Shahdadzai, 72 miles S. of Kalat, 5,100 ft. (no. 137A).—Fl. and fr. in July 1918.

Vern. Names: Bishkhaf (*bish* means donkey, *khaf* means ear), Maur (Br.), Mor (Bal.).

Salvia macrosiphon *Boiss, Diagn. ser. 1, pt. 11.*—Loc.: Mitasing, about 17 miles ESE of Panjgur, about 4,000 ft. (no. M218A, M218B).—Fl. in April 1918.

Vern. Name: Mor (Bal.).

ZIZIPHORA *L.*

Ziziphora clinopodioides *Lam. III. 1, 63.*—Loc.: Harboi, 18 miles ESE of Kalat, 9,000 ft. (no. 27, 27A). Fl. and fr. in Aug. 1917.

Uses: Regarded as a kind of mint.

Vern. Names: Purchink, Pudina.

NEPETA *Riv.*

Nepeta glomerulosa *Boiss. Diagn. ser. 1, pt. 21.*—Loc.: Harboi, 18, miles ESE of Kalat, 9,000 ft. (no.26, 72); Benn Chah, 22 miles N. of Surab (Jhalawan), about 6,200 ft. (no. M 384, M384A). Fl. and fr. in Aug. 1917.

Uses: Eaten as a relish by men, also by sheep, very much liked by cats (Hotson).

Vern. Name: Simsok (Br.).

Nepeta bracteata *Benth. in DC. Prodr. XII, 395.*—Loc.: W. side of Burida Pass 140 miles SSW of Kalat, below 4,250 ft. (no. 26A),
Vern. Name: Simsok (Br.).

Nepeta sp. ?—Loc.: Hodal Pass, N. side, about 80 miles S. of Panjgur, 2,200-2,900 ft. (no M220); Kori Kaur, W. of Ornach, about 3,600 ft. (no. 309; Gwambuk, about 60 miles S. by E. of Panjgur, about 2,700 ft. (no.M 206).
Vern. Names: Simsur, Kalporag (Bal., Br.), Bodaku (Bal. ?).

MARRUBIUM *Tourn.*

Marrubium vulgare *L. Sp. Pl. 533.*-Loc.: Kalat, about 6,350 ft. (no. M 393). Fl. and fr. in July 1918.
Vern. Name: Borkash (Br.).

OTOSTEGIA *Benth.*

Otostegia Aucheri *Boiss. Diagn. ser. 1. pt. 40.*—Loc.: Tapk, about 26° 19′ N, 62° 50′ E, about 1,750 ft. (no. M120); Kuchkan, about 17 miles W S W of Panjgur, about 2,900 ft. (no. M120A and B); Pishuk, 27° 33′ N, 65° 18′ E. (Kharan), about 5,300 ft. (no M120D); Teghab, 107 miles S. of Kalat, 4,150 ft. (no. 181); Wad 27° 20′ N, 66° 20′ E, about 4,000 ft. (no. 373); Nal, 27° 41′ N. 66° 13′ E, 3834 ft., very common (no. 337).; Panjgur, (no. M214B). Fl. and fr. from Aug. to Sept. 1917, May and June 1918.
Vern. Names: Samar (Bal., Br.), Sadikh (Br.), Kulinch ?.

TEUCRIUM *L.*

Teucrium stocksianum *Boiss. Diagn. ser. 2, IV, 58.*—Loc.: Hills near Ispika, about 20 miles NE. of Mand, about 1,200-1,500 ft. (no. M82); Wahir 25 miles S. by W. of Khozdar, about 4,200 ft. (no 309 A).—Fl. in Sept. 1917.
Vern. Name: Kalporag (Bal. Br.)

(To be continued.)

Printed and Published for the Proprietor by W. L. KING at the Methodist Publishing House, Mount Road, Madras.

THE

Journal of Indian Botany.

VOL. I. APRIL, 1920. No. 8.

THE PHYSIOLOGICAL ANATOMY OF THE PLANTS OF THE INDIAN DESERT

BY

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(*Continued from p. 197.*)

PAPILIONACEAE—(*Contd*).

Crotalaria Medicaginea *Lam.*—Figs. 102, 103. Epidermal cells tabular. Mesophyll bifacial. Veins embedded and enclosed in bundle-sheaths. Tannin sacs found near the veins. External glands absent. Assimilatory tissue in the axis parenchy-matous. Pericycle formed of stone-cells. Medullary rays uniseriate. Pith formed of thin-walled cells.

Indigofera linifolia *Retz.*—Epidermal cells tabular. Mesophyll isobilateral; Veins embedded and enclosed in bundle-sheaths. Tannin sacs in the middle of the mesophyll, in cortex and pith. Clothing hairs in the form of two-armed trichomes. External glands absent. Assimilatory tissue in the axis chlorenchymatous. Pericycle formed of bast fibres. Medullary rays uniseriate. Pith formed of thin walled cells.

Indigofera cordifolia *Heyne.*—Figs. 104, 105. Epidermal cells tabular. Mesophyll isobilateral. Veins embedded and enclosed in bundle-sheaths. Tannin sacs in the middle of the mesophyll, in cortex and pith. Clothing hairs in the form of two-armed trichomes. External glands absent. Assimilatory tissue in the axis chlorenchymatous. Pericycle formed of bast fibres. Medullary rays uniseriate. Pith formed of thin-walled cells.

Indigofera paucifolia *Del.*—Figs. 106, 107. Epidermal cells tabular, Mesophyll isobilateral. Veins embedded and enclosed in bundle-sheaths. Tannin sacs in the palisade tissue, in cortex and pith. Clothing hairs in the form of two-armed trichomes. External

glands absent. Assimilatory tissue in the axis chlorenchymatous. Pericycle formed of bast fibres. Medullary rays 1·2 seriate. Pith formed of thick-walled cells.

Indigofera argentea *Burm.*—Epidermal cells tabular. Mesophyll isobilateral. Veins embedded and enclosed in bundle-sheaths. Tannin sacs in the middle of the mesophyll, in cortex and pith. Clothing hairs in the form of two-armed trichomes. External glands absent. Assimilatory tissue in the axis chlorenchymatous. Pericycle formed of bast fibres. Medullary rays uniseriate. Pith formed of thin-walled cells.

Indigofera anabaptista *Steud.*—Epidermal cells tabular. Mesophyll isobilateral. Veins embedded and enclosed in bundle-sheaths. Tannin sacs in the middle of the mesophyll, in cortex and pith. Clothing hairs in the form of two-armed trichomes. External glands absent. Assimilatory tissue in the axis chlorenchymatous. Pericycle formed of bast fibres. Medullary rays uniseriate. Pith formed of thick-walled cells.

Psoralea odorata *Blatt. and Hall.*—Figs. 108. Epidermal cells tabular. Mesophyll isobilateral. Veins vertically transcurrent by means of colourless parenchyma and enclosed in bundle-sheaths. Tannin sacs found near the veins and in the soft bast. Intramural glands found in the leaf. Clothing hairs appressed and muriculate. External glands club-shaped. Assimilatory tissue in the axis chlorenchymatous. Pericycle formed of bast fibres. Medullary rays uniseriate. Pith formed of thick-walled cells.

Tephrosia incana *Grah.*—Epidermal cells tabular. Mesophyll bifacial. Veins vertically transcurrent by sclerenchyma. Veins provided with bundle-sheaths. Clothing hairs in the form of uniseriate trichomes with muriculate walls. Pericycle composed of groups of stone-cells. Tannin sacs in the middle of the mesophyll. External glands absent. Assimilatory tissue in the axis chlorenchymatous. Pericycle formed of stone-cells. Medullary rays uniseriate. Pith formed of thin-walled cells.

Tephrosia multiflora *Blatt. and Hall.*—Epidermal cells tabular. Mesophyll bifacial. Veins vertically transcurrent by sclerenchyma and provided with bundle-sheaths. Clothing hairs in the form of uniseriate trichomes with muriculate walls. External glands absent. Pericycle formed of groups of stone-cells. Tannin sacs in the middle of the mesophyll. Assimilatory tissue in the axis chlorenchymatous. Pericycle formed of stone-cells. Medullary rays uniseriate. Pith formed of thin-walled cells.

Alysicarpus vaginalis *DC.*—Figs. 109, 110, 111. Epidermal cells tabular with outer walls toothed. Mesophyll bifacial.

Veins vertically transcurrent by sclerenchyma and provided with bundle-sheaths. Tannin sacs absent. Clothing hairs hooked. External glands formed of a stalk-cell and of a globose head. Assimilatory tissue in the axis chlorenchymatous. Pericycle formed of stone-cells. Medullary rays 1-2 seriate. Pith formed of thin-walled cells.

Phaseolus trilobus *Ait.*—Fig. 112. Epidermal cells tabular with inner walls gelatinised. Mesophyll bifacial. Veins vertically transcurrent by collenchyma. Bundle-sheaths absent. Tannin sacs in the palisade tissue. Clothing hairs in the form of uniseriate trichomes with muriculate walls. External glands culb-shaped. Assimilatory tissue in the axis chlorenchmatous. Pericycle formed of bast fibres. Medullary rays 1-2 seriate. Pith formed of thin-walled cells.

Rhynchosia arenaria *Blatt. and Hall.*—Figs. 116, 117. Epidermal cells tabular. Mesophyll bifacial. Veins vertically transcurrent by sclerenchyma and provided with bundle-sheaths. Tannin sacs found in the middle of the mesophyll and in soft bast. Clothing hairs in the form of uniseriate trichomes with muriculate walls. External glands consisting of an uniseriate stalk and of a spherial head. Assimilatory tissue in the axis chlorenchymatous. Pericycle formed of stone-cells. Medullary rays 2-3 seriate. Pith formed of thin-walled cells.

Rhyncosia rhombifolia *Blatt. and Hall.*—Figs. 113, 114, 115.

Epidermal cells tabular. Mesophyll bifacial. Veins vertically transcurrent by sclerenchyma and not provided with bundle-sheaths. Tannin sacs found in the middle of the mesophyll and in soft bast. Clothing hairs in the form of uniseriate trichomes with muriculate walls. External glands formed of an uniseriate stalk and of a spherical head. Assimliatory tissue in the axis chlorenchymatous. Pericycle formed of stone-cells. Medullary-rays 2-3 seriate. Pith formed of thick-walled cells.

Structure of the Leaf:—Epidermal cells may be tabular with straight lateral walls, or may be polygonal with lateral walls undulated, as in species of *Crotalaria* fig, 100 and *Heylandia latebrosa* fig. 99. Outer walls are thickened and cuticularised; inner and lateral walls are thin. There are large thin-walled water-storing cells with outer and inner walls convexly arched outwards and inwards respectively, intercalated amongst the ordinary epidermal cells in *C. Burhia* fig. 100 and H. *latebrosa* fig. 99. The toothed condition of the outer walls in A. *vaginalis* may be the result of the arrest of parenchyma owing to the deficiency of water. Papillose differentiation of the outer walls is rare. Inner walls in P. *trilobus* are gelatinised.

Stomata are depressed and are found equally numerous on both the surfaces of the leaf when it is isobilateral, or are more numerous on the lower surface when it is bifacial. Stomata are surrounded by ordinary epidermal cells.

The mesophyll is isobilateral in *C. Burhia* fig. 100, species of *Indigofera* figs. 104, 106 and *P. odorata* fig. 108. It is bifacial in *H. latebrosa*, *C. medicaginea*, *A. vaginalis*, *P. trilobus* and species of *Rhyncosia*. The chief character of the mesophyll is the occurrence of large cells, distinguished by shape and contents in the middle of the mesophyll; they hold tanniniferous contents and are especially prominent in species of *Indigofera* figs. 104, 106, *Tephrosia* and *Rhyncosia*. In species of *Crotalaria*, *Psoralea* and *Alysicarpus* there is a layer of large polygonal cells in the middle, poor in chlorophyll and perhaps occasionally serving as an aqueous tissue. *P. trilobus* does not possess any differentiated layer of cells in the middle of the mesophyll.

The isobilateral arrangement of the palisade tissue is common and spongy parenchyma, when present on the abaxial side, is scantily provided with intercellular spaces. The reduction of the ventilating system in the mesophyll is a proof of the xerophytic nature of the plant.

Internal secretory organs are represented by tannin sacs. They occur in the middle of the mesophyll in *I. cordifolia* and in species of *Tephrosia* and *Rhyncosia* and in the palisade tissue in *I. paucifolia* and *P. trilobus*. In species of *Crotalaria* and *Psoralea* tannin sacs are very few and occur in the neighbourhood of the veins. Tannin sacs are not found in species of *Heylandia* and *Alysicarpus*. Sections of the leaf of *C. medicaginea* were found to be mucilaginous while changing them from lactic acid to glycerine; this may suggest the presence of mucilaginous cells in the mesophyll.

P. odorata is characterised by the occurrence of intercellular secretory receptacles, termed intramural glands. They occur close beneath the epidermis in the palisade tissue and are bounded towards the palisade tissue by a sheath of cells closely fitting together. The space is traversed by a number of narrow tubular secretory cells, curved more or less like meridians. The external walls of these cells are thickened and take part in the formation of the surface of the leaf. Intramural glands are much more numerous on the lower surface than on the upper.

Oxalate of lime is not found in any form in any of the members.

The veins are embedded in species of *Crotalaria* and *Indigofera*; they are vertically transcurrent above and below by means of collenchyma in *P. trilobus*, by sclerenchyma in species of *Heylandia*,

Tephrosia, *Alysicarpus* and *Rhyncosia*. The veins are few and do not anastomose freely, which suggests that the leaves do not transpire vigorously.

The hairy covering consists of clothing and glandular hairs. Clothing hairs are of the nature of uniseriate trichomes and have varied forms as follows:—

(*a*) With walls smooth or muriculate as in *H. latebrosa*, *C. Burhia* fig. 100 and species of *Tephrosia*, *Phaseolus* and *Rhyncosia*.

(*b*) Terminal cell bent in the form of a hook in *A. vaginalis* fig. 110.

(*c*) Terminal cell bent and lying parallel to the surface and with a muriculate surface in *P. odorata* fig. 108.

(*d*) Two-armed and formed of a stalk cell and of an unicellular two-armed terminal cell, the arms being equal in species of *Indigofera* fig. 105.

The covering of clothing hairs in isobilateral leaves is not dense and it should be noted that two-armed hairs in *Indigofera*, though few in number, are short-stalked and form a suitable light screen close to the surface of the leaf, against strong light and glare, which accelerates transpiration and is injurious to chlorophyll.

External glands are not found on the leaf of species of *Heylandia*, *Crotalaria*, *Indigofera* and *Tephrosia*. In species of *Rhyncosia* glandular hairs are formed of a short uniseriate stalk and of a spherical head fig. 114; they occur on both the surfaces. External glands in *P. odorata* and *P. trilobus* are club-shaped and consist of a short uniseriate stalk and of a head divided by horizontal and vertical walls. Glandular hairs in *A. vaginalis* are composed of a stalk-cell and a globose head, divided by horizontal and vertical walls; they occur only on the lower surface of the leaf.

It should be observed that external glands are found in a small number of species and sometimes only on the lower surface.

Structure of the Axis:—The epidermis is two-layered in species of *Heylandia*, *Crotalaria* and *Psoralea*; it is single layered in species of *Indigofera*, *Tephrosia*, *Phaseolus*, *Alysicarpus* and *Rhyncosia*. The outer walls are thickened and are arched convexly outwards.

Hairy covering has the same character as of that on the leaf. It should be noted that glandular hairs formed of a multicellular stalk and of an irregularly divided head are found in *I. argentea*.

Internal secretory organs are represented by tannin sacs. They are abundant in species of *Indigofera* and occur in the cortex and pith. Some of the vessels in *I. liniflolia* also hold tanniniferous contents. Tannin sacs occur in the soft bast of species of *Psoralea* and *Rhyncosia*.

Primary cortex is characterised by assimilatory tissue and collenchyma. The assimilatory tissue is formed of palisade cells in *C. Burhia;* in others it is chlorenchymatous. The collanchyma is developed in the ribs of the ribbed axis. Ribs are strengthened by sclerenchyma in *I. anabaptista, P. odorata* and *P. trilobus*. Cork was not developed in any of the species examined. The endordemis, when differentiated, consists of tabular cells.

The pericycle is composed of a composite ring of bast fibres in species of *Heylandia, Indigofera, Psoralea* and *Phaseolus*. It forms a composite ring of stone-cells in species of *Crotal aria, Tephrosia, Alysicarpus* and *Rhyncosia.* In species of *Heylandia* and *Phaseolus* groups of bast fibres are developed along three-fourth of the circumference of the axis, while along the remaining portion the pericycle is parenchymatous. This is curious and suggests that the axes are much inclined and that sclerenchyma is developed only on the upper side of the inclined axis. Small groups of bast fibres occur in soft bast of *Alysicarpus vaginalis.*

The perforations of vessels are simple. Size of lumen, abundance and arrangement of the vessels vary in different genera and even in species. These differences may be useful in diagnosis of genera and species, if due allowance is made for modifications introduced by conditions of the soil.

The vascular system, as a whole, is characterised by the poor development of vessels as regards size and abundance, by abundance of wood prosenchyma and by poorly developed wood parenchyma. These modifications are due to the arrest of the development of parenchyma owing to deficiency of water. A system of well developed water conducting tissue is not required in the axis of desert plants in which all structures are adapted to diminish transpiration. It should be observed that the size and abundance of vessels are usually inversely proportional to each other.

Soft bast usually forms a continuous ring. It is characterised by the occurrence of tannin sacs in species of *Indigofera, Psoralea* and *Rhyncosia* and by the presence of small groups of bast fibres in *A. vaginalis.*

Pith consists of thin-walled cells in species of *Heylandia* and *Crotalaria, I. linifolia, I. argentia,* species of *Tephrosia, A. vaginalis, P. tribolus* and *R. arenaria ;* and is formed of thick-walled and lignified cells in *I. paucifolia, I. anabaptista, P. odorate* and *R. rhombifolia.* Some of the pith cells in *I. paucifolia* and *I. argentia* hold tanniniferous contents. The pith composed of lignified cells adds to the rigidity afforded by the mechanical tissue; when it is formed of thin-walled cells it may serve occasionally as an aqueous tissue.

Structure of wood :—

NAMES OF SPECIES.	VESSELS.		INTERFASCICULAR WOOD PROSENCHYMA			MEDULARY RAYS		GENERAL REMARKS.
	LUMEN.	ABUNDANCE.	ARRANGEMENT.	ABUNDANCE.	LUMEN.	SIZE.	ABUNDANCE.	
H. latebrosa ...	Large.	Numerous.	Complete rows.	Scanty.	Large.	1 Seriate.	Numerous.	Vessels larger in the lower portion.
C. burhia ...	Small.	Few.	Complete rows.	Extensive.	Small.	,,	Few.	
C. medicaginea ...	Large.	Numerous.	,,	,,	Large.	,,	Numerous.	
I. linifolia ...	,,	,,	,,	Scanty.	Small.	,,	,,	
I. paucifolia ...	Small,	Few.	,,	Extensive.	,,	1-2 Seriate.	Few.	
I. argentea ...	Large.	Numerous.	,,	,,	Large.	1 Seriate.	Numerous.	
I. anabaptista ...	,,	,,	Incomplete rows.	Scanty.	,,	,,	,,	Rows of vessels in groups of 2-4.
P. odorata ...	,,	Few.	Complete.	Extensive.	,,	,,	Few.	Rows of vessels in groups of 3-4.
T. incana ...	,,	,,	Incomplete rows.	Not	Small.	,,	,,	
T. multiflora ...	,,	,,	,,	,,	,,	,,	,,	
A. vaginalis ...	,,	Numerous.	,,	,,	,,	1-2 Seriate.	Numerous.	
P. trilobus ...	,,	Few.	,,	Extensive.	Very large	,,	Few.	
R. rhombifolia ...	,,	,,	Complete.	,,	Small.	2-3 Seriate.	,,	
R. arenaria ...	,,	,,	,,	,,	,,	,,	,,	

Anomolous structures are represented by cortical vascular bundles in C. Burhia, fig. 101.

General Review

Outer walls of the epidermal cells are thickened and cuticularised. Spongy tissue is greatly diminished and the ventilating system is greatly reduced. Water-storing tissue is extensive in the leaf and occurs either in the epidermis or in the palisade tissue, or in the middle of the mesophyll. Tannin sacs are abundant. Secretory cavities are represented by intramural glands in *Psoralea odorata.* Oxalate of lime is not found in the leaf or axis. The system of veins is poorly developed. Clothing hairs are never unicellular; they are uniseriate trichomes, either simple, or hooked, or armed. Glandular hairs are either club-shaped or spherial and are not abundant.

The pericyle forms a composite ring either of groups of bast fibres or of stone-cells. Vessels have simple perforations and are not numerous. Inter fascicular wood prosenchyma is abundantly developed forming the ground work of the vessels. Wood parenchyma is poorly developed. Medullary rays are usually uniseriate and numerous.

The pith consists of thin-walled or thick-walled and lignified cells.

Anomelous structures are represented by cortical vascular bundles in *C. burhia.*

CAESALPINEAE

Cassia obovata, *Collad.*—Figs 118, 119. Epidermal cells with outer walls papillose. Stomata occurring on both the surfaces. Mesophyll isobilateral. Veins embedded. Clothing hairs unicellular. Assimilatory tissue formed of chlorenchyma. Vessels large. Medullary rays uniseriate. Pith formed of cells with thickened and lignified walls.

Structure of the Leaf:—The epidermal cells have outer walls drawn out into large papillage, fig. 118. The stomata are equally numerous on both the surfaces. Guard-cells are situated in the plane of surrounding cells; and the front cavity is placed in a deep depression formed by the outer papillose epidermal walls.

The mesophyll is isobilateral. The palisade tissue on the adaxial side consists of longer cells than those on the lower surface with transversely elongated cells between. The veins are embedded. The large veins are protected above and below by sclerenchyma; the smaller ones have large strands of sclerenchyma only on the lower side.

Hairy covering consists of unicellular curved hairs with perhaps a function of absorbing water. Walls are thin and superficially knobbed. Glandular hairs are not found in the leaf and axis.

Structure of the Axis :—The epidermal cells are small with outer walls thickened and papillose. The primary cortex is formed of chlorenchyma.

The pericycle forms a more or less composite ring of stone-cells. The wood is composite. Vessels are large and few ; they are more abundant in the inner half of the wood. Interfascicular wood prosenchyma is extensive. Wood parenchyma is more abundantly developed than in Papilionaceae and enclose the inner ends of the xylem bundles. The medullary rays are unseriate.

The pith consists of small cells with thickened and lignified walls.

MIMOSEAE

Acacia Senegal, *Willd.*—Figs. 120, 121. Epidermal cells with outer walls thickened and papillose. Stomata occurring on both the surfaces. Mesophyll formed of palisade tissue on the upper side and of arm-palisade tissue on the lower. Tannin sacs present in the leaf and axis. Veins embedded. Clothing hairs unicellular. Cork subepidermal. Pericycle forming a composite ring of stone-cells. Small groups of stone-cells in soft bast. Vessels large. Medullary rays uniseriate. Pith composed of cells with thick and lignified walls.

Structure of the Leaf:—The epidermal cells have outer walls thickened and papillose. Stomata occur on both the surfaces. The guard-cells are situated in the plane of surrounding cells and the front cavity is placed in a depression formed by the papillose outer walls of the epidermal cells.

The mesophyll is composed of 3-4 layers of palisade cells on the adaxial side and of arm-palisade tissue on the abaxial side. The middle tissue consists of a layer of large parenchymatous cells with tanniniferous contents. Internal secretory organs are represented by tannin sacs occurring in the middle of the mesophyll, in cortex and pith.

The veins are embedded. The veins of the mid-rib are protected on the lower side by strands of sclerenchyma.

The hairy covering consists of a few unicellular clothing hairs. Glandular hairs are not found.

Structure of the Axis :—The cortex is characterised by subepidermal cork. Some of the cells of the tanniniferous cortical parenchyma near the pericyclic stone-tissue contain solitary crystals of oxalate of lime.

The pericycle forms a more or less composite ring of stone-cells. Small groups of stone-cells occur in the soft bast. The wood is composite. Vessels are large and are arranged in incomplete rows. Interfascicular wood prosenchyma is extensive and is composed of small thick-walled cells with small lumina. The medullary rays are uniseriate. Wood parenchyma is little developed.

Pith is composed of small cells with thickened and lignified walls.

ROSACEAE

Neurada procumbens *L*.—Figs. 122, 123, 124.—Epidermal cells tabular with outer and inner walls thickened and convexly arched outwards and inwards respectively. Stomata found on both the surfaces and accompanied by ordinary epidermal cells. Hairs uncellular and wooly. External glands absent. Mesophyll composed wholly of short palisade cells. Internal secretory cells with mucilaginous membrances on all sides and occurring near the veins in the leaf, and in collenchyma, cortical parenchyma, medullary rays and pith of the axis. Epidermal cells with tanniniferous contents. Leaves many ribbed. Smaller veins embedded. Larger veins vertically transcurrent by collenchyma. Epidermal cells of the axis with outer-walls papillose. Medullary rays broad. Interfascicular wood prosenchyma absent. Pith composed of thin-walled cells. Pith cells with mucilaginous walls towards the periphery.

Structure of the Leaf:—The epidermis consists of tabular cells with outer and inner walls convexly arched outwards and inwards respectively. Lateral walls are thin and straight. Epidermal cells hold tanniniferous contents. The stomata are more numerous on the lower surface and are surrounded by ordinary epidermal cells. The guard-cells are situated in the plane of surrounding cells and the front cavity is placed in a depression formed by the outer thickened epidermal walls fig. 123. The stomata on the axis are similar to those on the leaf.

The mesophyll is wholly composed of short palisade cells fig. 122. Internal secretory organs are represented by cells with mucilaginous membranes on all sides and by epidermal cells of the leaf with tanniniferous contents. Cells with mucilaginous membranes occur near the veins, at the inner margin of cortex, in the medullary rays and in the pith tissue towards the periphery. Tanniniferous contents in the epidermal cells of the leaf give an acrid taste to foliage leaves and prevent them from being easily devoured by animals.

Oxalate of lime is found in the form of numerous small clustered crystals near the veins of the leaf and in collenchyma and soft bast of the axis. The leaves are many ribbed, the ribs being prominent

beneath and grooved above. The smaller veins are enclosed in a sheath of cells, some with mucilaginous membranes and others with clustered crystals. The larger veins are vertically transcurrent above by collenchyma.

The hairy covering is dense and consists of clothing hairs on the leaf and axis. The clothing hairs are unicellular, long and woolly figs. 122, 124; they are more numerous on the lower surface of the leaf.

Structure of the Axis:—The epidermis consists of polygonal cells with outer walls thickened and papillose. The inner walls are thickened; the lateral walls are thin and undulated.

The cortex fig. 124 is composed of collenchyma on the outer side and of an extensive tissue of thin-walled colourless cells on the inner side with perhaps occasionally a water-storing function. Cells at the inner margin of the cortex have mucilaginous membranes.

Sclerenchymatous pericycle is not developed. The wood is composed of large xylem bundles separated by broad medullary rays some of the cells of which have mucilaginous membranes. Interfascicular wood prosenchyma is not developed.

The pith cells towards the periphery are mucilaginous.

LYTHRACEAE

Ammania baccifera *L.*—Fig. 125. Epidermis formed of thin-walled tabular cells. Clothing hairs absent. Oxalate of lime not found. Pericycle formed of bast fibres, with thin walls and large lumina. Small groups of thick-walled cells found in the pith formed of thin-walled cells.

Ammania desertorum *Blatt. & Hall.*—Fig. 126. Epidermal cells tabular with outer walls thickened and convexly arched outwards. Clustered crystalls found near the veins. Conical unicellular hairs with verrucose walls occurring on the axis and on the upper surface of the leaf. Pericycle formed of bast fibres with thick walls and with small lumina. Pith composed of thin-walled cells.

Structure of the Leaf:—The epidermal cells in *A. baccifera* fig. 125 are tabular and thin-walled except at the margin where the outer walls are thickened and convexly arched outwards. In *A. desertorum* the epidermal cells have the outer walls thickened and convexly arched outwards. The cuticle is striated. The lateral walls are thin and straight. The margins are curved downwards.

Stomata are more numerous on the lower surface and are surrounded by ordinary epidermal cells. Guard-cells are elevated and the front cavity is on a level with the surface figs. 125, 126. The stomata on the axis are similar to those on the leaf.

(To be continued.)

Plate XIII

105. *Indigofera cordifolia.*
Hair on the leaf.
Oc. 6 Com.; Ob. 8 mm. Ap.

106-107. *Indigofera paucifolia.*
106. T. S. of the leaf.
Oc. 2 Com.; Ob. 3 mm. Ap.
107. T. S. of the axis.
Oc. 4 Com.; Ob. 8 mm. Ap.

108. *Psoralea odorata.*
T. S. of the leaf.
Oc. 4 Com.; Ob. 8 mm. Ap.

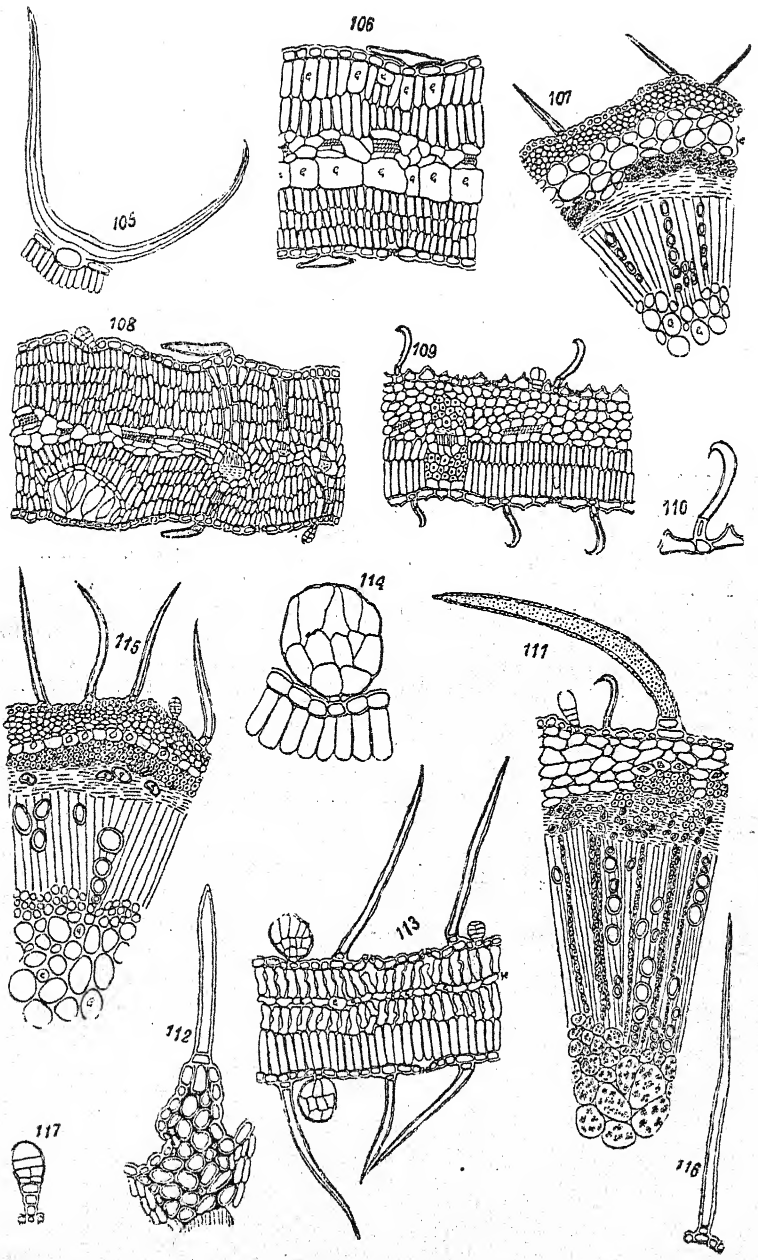
109-111. *Alysicarpus vaginalis.*
109. T. S. of the leaf.
Oc. 6 Com.; Ob. 8 mm. Ap.
110. Hair on the leaf.
Oc. 4 Com.; Ob. 3 mm. Ap.
111. T. S. of the axis.
Oc. 6 Com.; Ob. 8 mm. Ap.

112. *Phaseolus trilobus.*
Hair on the upper side of the mid-rib of the leaf.
Oc. 4 Com.; Ob. 8 mm. Ap.

113-115. *Rhyncosia rhombifolia.*
113. T. S. of the leaf.
Oc. 6 Com.; Ob. 8 mm. Ap.
114. Glandular hair on the leaf.
Oc. 6. Com.; Ob. 3 mm. Ap.
115. T. S. of the axis.
Oc. 4 Com.; Ob. 8 mm. Ap.

116-117. *Rhyncosia arenaria.*
116. Hair on the leaf.
Oc. 6 Com.; Ob. 8 mm. Ap.
117. Glandular hair on the axis.
Oc. 4 Com.; Ob. 8 mm. Ap.

N.B.—To get the original dimensions multiply by 1·7.



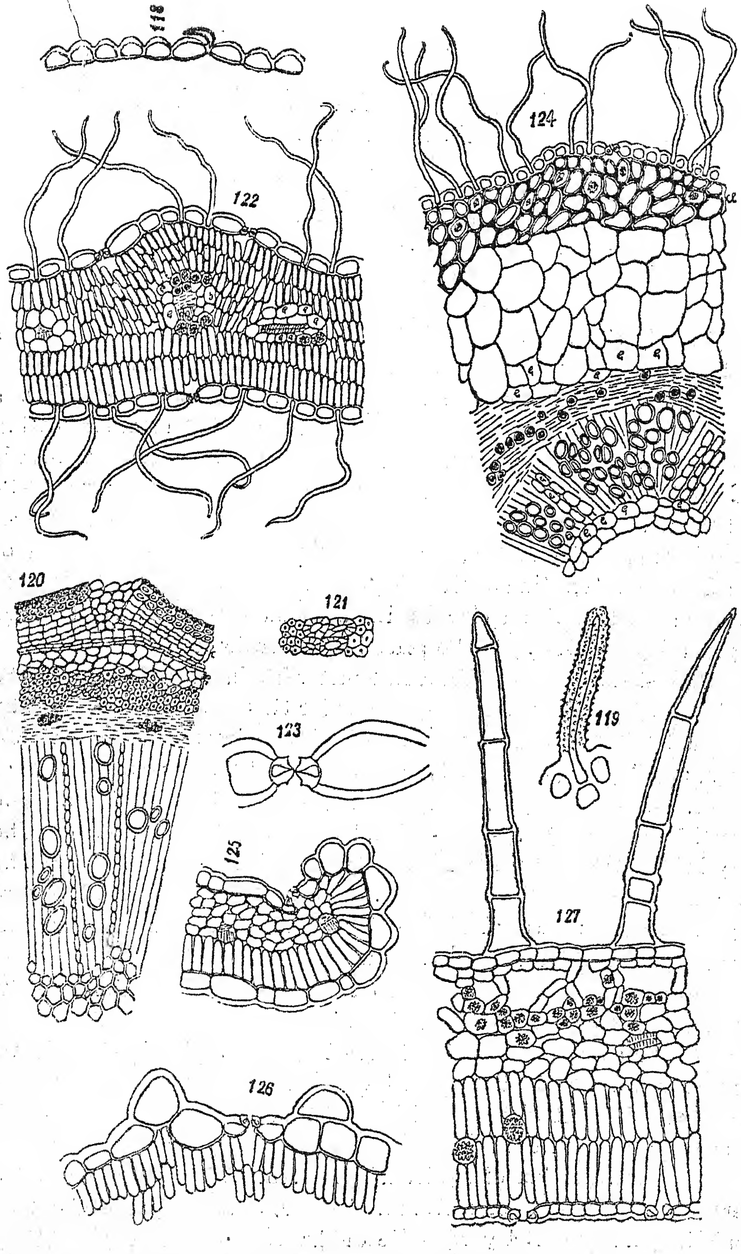
T. S. Sabnis del.

PLATE XIII.

Plate XIV

118-119. *Cassia obovata.*
118. T. S. of the leaf showing epidermis.
Oc. 6 Com.; Ob. 8 mm. Ap.
119. Hair on the axis.
Oc. 6 Com.; Ob. 3 mm. Ap.
120-121. *Acacia Senegal.*
120. T. S. of the axis.
Oc. 6 Com.; Ob. 8 mm. Ap.
121. T. S. of the axis showing sclereids between the pericyclic stone cell groups.
Oc. 8 Com.; Ob. 8 mm. Ap.
122-124. *Neurada procumbens.*
122. T. S. of the leaf.
Oc. 4 Com.; Ob. 8 mm. Ap.
123. Stoma on the leaf.
Oc. 6 Com.; Ob. 3 mm. Ap.
124. T. S. of the axis.
Oc. 4 Com.; Ob. 8 mm. Ap.
125. *Ammania baccifera.*
T. S. of the leaf.
Oc. 6 Com.; Ob. 8 mm. Ap.
126. *Ammania desertorum.*
T. S. of the leaf showing epidermis.
Oc. 6 Com.; Ob. 8 mm. Ap.
127. *Trapa bispinosa.*
T. S. of the leaf.
Oc. 4 Com.; Ob. 3 mm. Ap.

N.B.—To get the original dimensions multiply by 1·7.



T. S. Sabnis del PLATE XIV.

NOTE ON THE FLOATING ISLANDS OF RIWALSAR.

BY

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In July 1916, Marietta Pallis published an interesting paper on "The Structure and History of Plav: the floating fen of the Danube" in the Journal of the Linnean Society (Vol. XLIII, No. 291). I believe it is not generally known among botanists that a similar floating fen on a small scale occurs in the Outer Himalayas in Mandi State. The writer had an occasion to visit the place in August 1919 and though it was not unfortunately possible to undertake a detailed investigation of the floating islands or to make a large collection of plants, some interesting observations were however made. This note has been written with a view to induce somebody else with a better opportunity to investigate the place in greater detail.

The islands as stated above are met with in Mandi State in the freshwater lake at Riwalsar, which is for this reason held sacred by the Hindus and the Tibetans (Buddhists) for whom it is an important place of pilgrimage. The lake lies about 10 miles south-west of Mandi, surrounded by hills and some 5,000 feet above sea-level. The Mandi State Gazetteer says practically nothing about the fen. The only information given there in connection with this paper is:—"The circumference of the lake exceeds a mile and its waters are of immense depth. There are many large floating islands on its surface and this singular fact is attributed to its sancity."

No data are available as to the exact depth of the lake, its circumference or the exact size of the islands.

The first point of botanical interest is that the floating islands are formed by *Phragmites* like the Plav mentioned above. A few other plants are also met with in addition but they do not contribute much to the formation of the islands.

The total number of the islands is seven. The largest (known as Parbati's island) is, as seen from a distance, of a few yards about 20 yards long and about 4 yards wide and has rounded ends. The others are much smaller. The islands are formed practically wholly by a species of *Phragmites*, apparently *P. communis*, which forms very

tall clusters. One of the islands (known as Brahma's) has a small willow tree growing on it. It had another shrub also which looked like a rose and the writer was told that it was a rose. This island also bore a flag on a tall pole placed their by the Brahmans. The only other prominent plant on the islands was an aroid which could not be identified further.

All along the margins of the lake the ground at the time of the visit, the rainy season was very swampy. The aquatic plants growing on the bank of the lake were chiefly the following:—Some grasses and sedges, including *Phragmites*; a *Nymphaea*, a *Trapa*, *Polygonum barbatum*, a *Ceratophyllum*, a *Lemna* and an *Azolla*.

It may be mentioned that the islands move by the action of the breeze, the reeds acting as sails, though the Brahmans there believe in their supernatural and independent movement.

I was told that the level of the lake rises slightly during the rains, but the lake has a permanent supply of water from a subterranean spring and there is a permanent outlet also.

No boats are available at Riwalsar and everything necessary for the investigation should be arranged for beforehand.

THE VASCULAR CONNECTIONS AND THE STRUCTURE OF THE TENDRILS IN SOME CUCURBITACEAE

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During 1917 and 1918 the writer investigated the anatomy of a number of cultivated species belonging to the Cucurbitaceæ. A few writers have already dealt with the subject, and special mention must be made of Tondera (4) who has carefully investigated the vascular connections of a number of species of this family, and Muller (3) who has worked out the anatomy of the tendrils. The writer has re-examined some of the species worked out by these writers. Their results have been confirmed in a general way. Since however these two papers are not easily available to the ordinary reader and many species investigated by the writer have not been investigated by these writers and in view especially of some interesting results obtained, it is proposed to give a brief summary of the results arrived at by the writer.

It is well-known that the vascular bundles in the stems of the Cucurbitaceæ are generally arranged in two rings of five bundles each. The bundles are usually known as bicollateral as they possess phloem towards the inside of the xylem in addition to the external phloem. The bundles of the inner ring are as a whole larger than the outer bundles. These facts should be borne in mind in the following description unless otherwise stated.

Another point to be remembered is the position of the various organs at a node near the leaf-axil. Usually a number of structures are met with there arranged in a transverse row. In *Benincasa cerifera*, for example, in a ground plan of the node, beginning from the left, we found the following:—a tendril, a vegetative bud, a flower, a glandular structure looking like a rudimentary leaf. The last structure is absent in some species, and has a different form in some others. These differences would be indicated at the proper places.

Methods

In addition to free-hand sections other methods were also employed in the investigation. In some cases complete series of

sections were prepared through the nodes to study the course of the vascular bundles. In other pieces of stem were macerated in a suitable medium. In some cases both methods were tried.

A few words may be said about maceration. Several chemical reagents were tried, but none was found satisfactory. Even boiling in tap water was found too drastic. Ultimately the pieces of stems with their attached organs were left in ordinary tap-water for a number of days—about five in summer and about ten in winter—and then the vascular skeleton was prepared by teasing out the softer tissues.

The following species were studied. The methods adopted are also indicated.

1. **Benincasa cerifera** *Savi.* Maceration.
2. **Lagenaria vulgaris** *Seringe.* Maceration.
3. **Citrullus vulgaris** *Schrad.* Free-hand sections.
4. **Trichosanthes anguina** *Linn.* Serial sectioning.
5. **Trichosanthes dioica** *Roxb.* Maceration.
6. **Luffa acutangula** *Roxb.* Serial sectioning and maceration.
7. **Luffa pentandra** *Roxb.* Maceration.
8. **Cucumis melo** *Linn.* Serial sectioning and maceration.
9. **Cucumis momordica** *Roxb.* Free-hand sections.
10. **Momordica echinata** *Linn.* Serial sectioning and maceration.
11. **Momordica charantia** *Linn.* Serial sectioning.
12. **Cucurbita maxima** *Duchesne.* Maceration.

Of these species Tondera has figured the vascular connections of 1, 2 and 8; while Muller has figured the tendril-anatomy of No. 4.

After this preliminary account we may pass on to the details in the species investigated.

BENINCASA CERIFERA.

In the axil [1] of the leaf we find a row of four different organs. From the left, we have a two-armed tendril, a vegetative bud which sometimes developes into a shoot, a flower and lastly a glandular structure standing erect and with margins rolled inwards, resembling a rudimentary leaf. (Fig. 1.)

The stem is five-angled as usual in the family. In mature specimens the inner and the outer rings of vascular bundles are very near each other and very nearly merge into one ring. (Fig. 2)

[1] None of these structures is really axillary. In the Cucurbitaceæ most of the structures occurring at this place are extra-axillary. The word is used merely for the sake of convenience throughont the paper.

The leaf-stalk is dorsiventral in its organisation, markedly so in its upper part where it has a distinct groove on its adaxial side. The number of vascular bundles varies from nine to eleven, those nearest the groove being the smallest. (Fig. 3)

The basal part of the tendril is radial in section, the number of bundles various from six at the lower to ten in the upper part, and they are as a rule arranged in one ring. There is absolutely no trace of a ventral groove as is present in the petiole. (Fig. 4)

Both the branches of the tendril show a dorsiventral structure with a distinct groove on the apparently upper surface. The vascular bundles are five in number in the form of an arc open above as seen in a transverse section. (Fig. 5)

The vascular connections at the node are as follows :—The traces from the tendril, the vegetative bud and the flower-stalk all pass through the cortex and join the bundles of the inner ring. The leaf-stalk sends three traces into the cortex. Of these, one (median) passes down the internode below without anastomosing with any bundle at the node; the two lateral traces join the two adjacent bundles of the outer ring, each with the one on its own side. One bundle of the inner ring, while coming from the upper internode, gradually decreases in size and ultimately ends blindly immediately above the node or just reaches it. The bundles of the inner ring anastomose at the node and this ring receives a bundle from the outer ring also to take the place of the one that has just ceased at each node. Thus at every node one bundle of the inner ring stops and a bundle from the outer ring joins the inner ring to take its place[1] while the place of the latter is taken by the median leaf-trace which passes down the lower internode without anastomosing. The gradual decrease in size of one of the bundles of the inner ring at each internode, as described above, is the cause of the dorsiventrality of the arrangement of the vascular bundles common in the family. (3)

It is clear from the above description that the bundles of the outer ring are really continuations of the leaf-traces, while the bundles of the inner ring are mainly cauline.

Lagenaria vulgaris.

The organs at the node beginning from the left are, a branched tendril with five arms very close to each other, a bud and a flower. The glandular organ is missing.

The vascular structure of the stem and the leaf-stalk is in general the same as in *Benincasa cerifera*.

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[1] This new inner bundle is not, however, a direct continuation of the outer bundle.

The basal part of the tendril is radial in section and has a ring (as seen in t. s.) of six to nine bundles which anastomose at different levels.

The arms of the tendrils are similar in structure to those of *Benincasa cerifera.*

The vascular connections of the tendril and the leaf with the stem are also similar.

Citrullus vulgaris.

The arrangement of organs at the node is similar to that in *Benincasa*, except that the flower is here replaced by an inflorescence. The tendril is two-armed.

The stem and leaf-stalk do not present any great differences from the first type.

The basal part of the tendril is radial with nine to twelve or thirteen bundles which are so arranged that large and small bundles alternate. The branches of the tendrils show the same structure as in the first type except that the bundles are seven at the base diminishing to five near the apex.

Trichosanthes anguina.

The relationships of the organs at the node are the same as in *Benincasa cerfera* but the tendrils are four-armed.

The structure of the stem and the petiole is in general similar to that of the first type.

The basal part of the tendril in transverse section is slightly six-lobed and has six bundles in one ring. There is no trace of a ventral groove so that the structure is radial. The tendril-arms have a distinct groove and the bundles are arranged on the type of the petiole.

The vascular bundles of the tendril unite with the bundles of the inner ring of the stem, while the leaf-traces are connected with the outer bundles as described before.

Each tendril-arm receives three branches from three bundles of the tendril situated on the side on which the arm is given off.

In one case it was found that a ripe elongated fruit was apparently arising immediately below the branching point of a tendril. On cutting sections of the lower part of the tendril it was found that it was merely a case of fusion of the flower-pedicel with the basal part of the tendril. Goebel mentions a simlar case.

Trichosanthes dioica.

The arrangement of the organs at the node is the same as in the last species but the tendrils are simple.

The structure of the stem and the petiole is of the usual type. The structure of the tendril however is dorsiventral throughout its entire length. At the base there are seven vasculer bundles which are reduced to five in the upper part. The traces of the tendril join the inner bundles of the stem just like the traces of the branched tendrils of other species. The middle leaf-trace passes straight down without anstomosing, while the lateral leaf-traces join the adjacent bundles of the outer ring of the stem.

LUFFA ACUTANGULA.

The arrangment of the organs at the node is as in Benincasa. The tendriis are four-armed, the branches arising along a very compact spiral.

The strûcture of the stem, petiole and the base of the tendril is similar to that in *Benincasa cerifera*.

The main arm of the tendril, the one which is in continuation of the basal part, has a structure similar to that of the basal part. The other arms have a petiole-like type of structure, having a distinct groove along the ventral side and horse-shoe arrangement of bundles.

The vascular connections of the various organs with the stem bundles are similar to those of *Benincasa cerifera*.

LUFFA PENTANDRA.

The arrangement of the organs at the node is as follows a four-armed tendril, a bud, an inflorescence and a triangular leaf-like appendage bearing several circular facets.

The structure of the stem, petiole, the base of the tendril and the tendril-arms is similar to that of the corresponding organs in *Benincasa cerifera*. The vascular connections are also similar.

CUCUMIS MELO.

The disposition of the organs at the node is as usual. The glandular organ is a circular faceted structure. The tendrils are simple.

The stem and the petiole do not show any unusual feature in their structure.

The tendril is dorsiventral throughout its entire length as shown by the presence of the groove and the horse-shoe arrangement of the bundles.

The vascular connections of the tendril-traces and the leaf-traces are the same has described for *Benincasa cerifera*.

CUCUMIS MOMORDICA.

The disposition of the organs at the node and the internal structure of the various organs is in general similar to that in the last species.

MOMORDICA ECHINATA.

Both simple and branched two-armed tendrils are found on the same plant. The disposition of the nodal organs is as in *Citrullus vulgaris* except that the leaf-like appendage is absent.

The stem and the petiole show the usual structure, the latter with only seven vascular bundles.

The base of the tendril, both in branched and unbranched specimens is four-lobed and has four bundles only. The arms in the case of the branched tendrils, and the upper portion of the tendril in the case of the simple ones, possess a dorsiventral outline showing a distinct ventral groove and five bundles arranged in a horse-shoe manner.

The vascular connections are like those of *Luffa acutangula* and the rest, already described or to be described later.

MOMORDICA CHARANTIA.

Tendrils are all simple. To the right of the tendril at the node is a vegetative bud and next to this a flower. The glandular organ is absent.

The stem and the petiole has the usual structure.

The base of the tendril is four-lobed as in *Momordica echinata*. It has four bundles. One of them divides into two a little higher up and the tendril at the same time develops a groove, thus becoming petiole-like in its organisation.

The bundles of the tendril anastomose with the bundles of the inner ring of the stem.

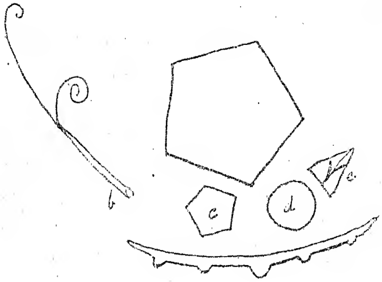
CUCURBITA MAXIMA.

The tendrils in this species are four or five-armed. The vascular connections of the leaf-traces and the tendril-traces are the same as described for *Benincasa cerifera*.

Concluding remarks

It will be seen from what has been described before that of the twelve species examined, four, *i.e.*, *Cucumis melo*, *Cucumis momordica*, *Trichosanthes dioica and Momordica charantia*, have simple tendrils; *Momordica echinata* has both simple and branched tendrils; while all the rest have branched tendrils.

The vascular connections of the stem with the tendril, the flower, the vegetative bud and the leaf have been examined in all except *Citrullus vulgaris*. The structure of the leaf-stalk and the tendrils at various levels has been examined in all except *Cucurbita maxima*.



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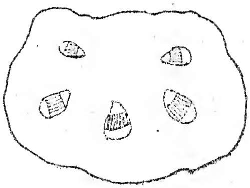

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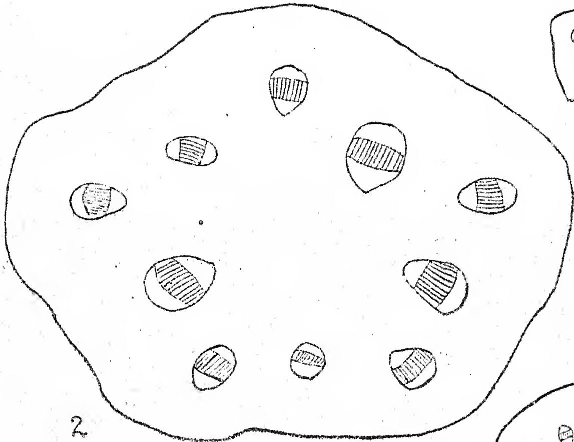

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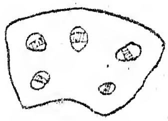

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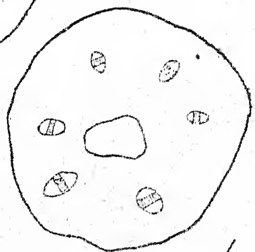

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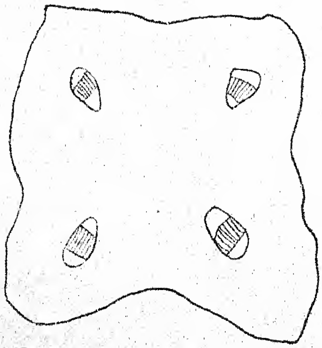

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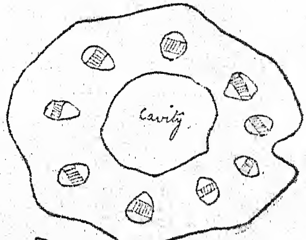

3

The results are as follows :—

1. The vascular bundles from the flower, the vegetative bud and the tendril (whether simple or branched) in all the species examined unite with bundles of the inner ring of the stem at the node at which these organs arise.

2. Three bundles enter the stem from the leaf-stalk. The median passes straight down through the internode without uniting with any other bundle. The two lateral bundles unite with the adjacent bundles of the outer ring of the stem, one on each side.

3. At each node one of the bundles of the inner ring stops and its place is taken by a bundle from the outer ring. The bundles of the inner ring anastomose at the nodes.

4. The base of the tendril in all species with branched tendrils is organised radially the bundles being arranged in a ring and there being no groove, such as is present in the petiole. This is also true of the simple tendrils of *Momordica echinata*.

5. The tendrils in all the species with simple tendrils except *Momordica charantia* are organised on the type of the petiole with horse-shoe arrangement of bundles and a groove on one side throughout their entire length. In *Momordica charantia* the tendril is radially organised at the base and dorsiventrally above.

6. In all species the upper part of the simple tendrils and the arms of the branched tendrils throughout their entire length are organised on the type of the petiole. The main arm of the tendril which is a continuation of the basal part in *Luffa pentandra* is, however, radially organised. The upper part of this arm was unfortunately not examined. It would probably possess a dorsiventral structure.

The following conclusions are drawn from the above results :—

1. The vascular connections and the structure of the basal part of the branched tendrils show that they are homologous with the ordinary shoots.

2. The arms of the branched tendrils and the upper part of the simple tendrils are homologous with the ordinary leaves.

3. The simple tendrils have been derived from the branched tendrils and therefore homologous with them. Species of *Momordica* show the transition in *M. echinata* possessing both simple and branched tendrils and in *M. charantia* possessing only simple tendrils the base of the tendril is always radially organised. In other species with simple tendrils the modifications has gone still further and even the basal part has become petiole-like.

It may be stated that conclusions one and two are in general agreement with the conclusions of Muller and Tondera, but according

to Goebel (1) the simple tendrils are modified prophylls while a branched tendril represents a prophyll adherent to an axillary shoot.

My thanks are due to Professor S. R. Kashyap for much suggestive criticism and other help in the preparation of this paper. The work was done under his supervision in the Government College Biological Laboratory before the writer joined the Islamia College, Peshawar.

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Explanation of figures. (1-5, Benincasa cerifera; 6-7, Momordica echinata.) xylem is shaded throughout.

1. Disposition of organs at the node. a, leaf ; b, tendril ; c, vegeta-bud ; d, flower ; e, glandular organ.
2. Transverse section of steam in outline.
3. Transverse section of petiole in outline.
4. Transverse section of the base of a tendril in outline.
5. Transverse section of an arm of a tendril.
6. T. S. of the vase of the tendril.
7. T. S. of an arm of a tendril

CONTRIBUTIONS TOWARDS A FLORA OF BALUCHISTAN

From materials supplied by Col. J. E. B. Hotson, I.A.R.O

BY

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(Continued from last issue)

Plantaginaceae.

PLANTAGO *L.*

Plantago maior, *L. Sp. Pl. (1753)* 112.—Loc.: Khudabadan, ¼ mile N. of Panjgur about 3,000 ft.; jerri, 147 miles SSW of Kalat, 3,800 ft. (no. 222).—Fr. in Aug. 1917.

Vern. Name: Khari Gosh (Bal.).

Plantago maior, *L.* var. **minor** *Boiss.*—Loc.: Spring on Harboi, 18 miles to SE of Kalat, 8,600 ft. (no. 68); Iskalku, 7 miles S. of Kalat, 7,500 ft. (no. 90).—Fl. in Aug. 1917.

Uses: Eaten by "gad" (Hotson).

Plantago lanceolata. *L. Sp. Pl. 113.*—Loc.: Khozdar. 27°, 48′ N, 66° 371 E, about 4,100 ft. (no. 344); Surab (Jhalarwan), 28° 29′ N, 66° 16′ E, about 5,700 ft (no. M 378); Panjgur about 3,100 ft. (no. M 156).—Fl. and fr. in March and June 1918, Sept. 1917.

Vern. Name: Danichk (Bal. Br.), Barz (Br.), Aspangara (Urdu, Sind.).

Plantago lagocephala *Bunge in Mem. Sav. Etr. Petersb. VII (851) 445.*—Loc.: Dokop, 10½ miles E. of Mand, about 650 ft. (no. M 68), Rek Chah, 11 miles E. of Chambar, Kolwa, about 1,800 ft. (no.M 271). —Fl. and fr. in March and April 1918.

Uses: Various preparations are used against gripes, constipation, white "urine," and boils.

Vern. Name: Danishk (Bal.), Pidarri (Br.), Isufgol (? Urdu).

Plantago psyllium *L. Sp. Pl. 115*—Loc. Garmkan, 1 mile NE of Panjgur about 3,135 ft. (no. M162).—Fr. in March 1918.

Plantago ciliata, *Desf. Fl. Atl. I 137, t. 39, var. lanata* Boiss.—Loc.: Kharan about 3,600 ft. (no. 303).—Fr. in April 1918.

Vern. Name: Naren Danichk (Bal.).

Plantago sp.—Loc.: Spring on Harboi, 18 miles ESE of Kalat, 8,600 ft. (no. 70); Surab (Jhalarwan), 28° 29′ N, 66° 16′ E, about 5,700 ft. (no. M 378A).—Fl. in June 1918, fr. in June 1918, Aug. 1917.

Vern. Name: Barz, Mashana Choteli (Br.).

Nyctaginaceae

BOERHAAVIA *L.*

Boerhaavia elegans *Chois. in. DC. Prodr. XIII, 453.*—Loc.: Hodal Pass, about 85 miles S of Panjgur, 2,900 to 3,400 ft. (no, M 255), Mandi Parag, about 22 miles E of Chambar (Kolwa). about 1,900 ft. (no. M 275; Gwambuk, about 69 miles SE of Panjgur, about 2,700 ft. (no. M 208); Rari Dan, 175 miles SW of Kalat, 2,300 ft. (no. 285).

Vern. Name: Askkah Kohi Pindal (Bal.), Roding Babi (Br.).

Boerhaavia plumbaginea *Cay. I, II, 7, tab. 112.*—Loc.: Chhuttok, 90 miles S. of Kalat, 4,500 ft. (no. 117).

Boerhaavia diffusa *L. Sp. Pl. (1753) 3.*—Loc.: Rari Dan, 175 miles SW of Kalat, 2,300 ft. (no. 219 A); Rar Kaur, 165 miles SW of Kalat, about 3,500 ft. (no .219 B); W side of Burida Pass, 140 miles SSW of Kalat, under 4,250 ft. (no. 219); Gwambuk, about 60 miles SE of Panjgur, about 2,700 ft. (no. M 208A).—Fl. in April 1918, Aug. 1917. Fr. in. Sept. 1917.

Vern. Name: Saring (Bal.).

Boerhaavia verticillata *Poir. Encycl. Meth. V (1804) 56.*—Loc.: Near Manguli, 197 miles SSW of Kalat, about 2,450 ft. (no. 246); Pirandar, 205 miles SSW of Kalat, about 1,900 ft. (no. 261).—Fl. in Sept. 1917.

Vern. Name: Wal (Bal. and Br).

Illecebraceae

GYMNOCARPOS *Forsk.*

Gymnocarpos decandrum *Forsk. Fl. Aeg. Arab. 65 (1775).*—Loc.: Rari Dan, 170 miles SW of Kalat, 2,300 ft. (no. 289); Tapk, about 62° 50′ E, 26° 19′ N, about 1,750 ft. (no. M34A); NE of Hoshap, about 60 miles ENE of Turbat, about 2,000 ft. (no. M34).—Fl. in Sept. 1917. Fr. in March 1918.

Vern. Name: Mazhong (Bal. and Br.), Zafti (Br).

Amarantaceae

DIGERA *Forsk.*

Digera arvensis Forsk. *Fl. Aeg Arab. 65.*—Loc.: Ornach, 380 ft. (no. 183A). Fl in Sept. 1917.

Vern Name: Maliro (Br. Bal.).

AMARANTUS *L.*

Amarantus paniculatus *L. Sp. Pl. ed. 2, 1406.*— Loc.; Surab, 43 miles S. of Kolat, 5,750 ft. (no. 110).—Fr. Aug. 1917.

Amarantus gangeticus *L. Syst. Nat. ed. 10 (1759) 1268.*— Loc.: Korak (Pelar), 130 miles S. by W. of Kalat, 1,900 ft. (no 227); Teghab, 107 miles S of Kalat, 4,150 ft. (no. 183).— Fl. and fr. in Aug. and Sept. 1907.

Vern. Name: Maliro (Bal. and Br.).

AERUA *Forsk.*

Aerua tomentosa *Forsk. Fl. Aeg. Arab. CXXII and 170.*—Loc.: Near Kuldan (W. Kolwa), about 85 miles E. by. N. of Turbat, about 2,400 ft. (no.M135B) ; Gwambuk, about 60 miles SE of Panjgur, about 2,700 ft. (no.M209) : Burida Pass, 140 miles SSW of Kalat up to 4,250 ft. (no. 213) ; Awaran, Kolwa, 26° 24′ N, 65° 12′ E, about 1,750 ft. (no.M282) Zahrin, Kahur, 16 miles N of Pasni about 200 ft. (no.M45) ; Las Bela, about 700 ft. (no. 213A) ; near Ornach, about 3,300 ft. (no. 314).— Fl. and fr. in Aug. and Oct. 1917.

Uses: The flowers when fully developed are dried and used for stuffing cushions (Hotson).

Vern. Names: alisht Bur, Isped Phul (Br. and Bal.), Pihunpulli (Br.), Kirech (Bal.), Buh (Lassi Sindhi).

ACHYRANTHES *L.*

Achyranthes aspera *L. Sp. Pl. 204.*— Loc : Dalnakher, 29 miles N. of Las Bela, about 2,000 ft. (no. 396) ; Jebri, 147 miles SSW of Kalat. 3,850 ft. (no. 232); Khozdar, 27° 48′ N, 66° 37′ E, about 4,100 ft, (no. 351).—Fl. and fr. in Aug., Sept. and Oct. 1917.

Vern. Name: Khari Gosh = Donkey's Ear (Bal.).

Chenopodiaceae.

CHENOPODIUM *L.*

Chenopodium album *L. Sp. Pl. 219.*—Loc. Panjgur, about 3,100 ft. (M175). Fl. and fr. in March 1918.

Uses: Eaten as a vegetable.

Vern. Name: Batu (Sind.).

Chenopodium opulifolium *Schrad. in DC. Fl. Franc. V. 372.*—Loc.: Panjgur (no.M324).; Manguli (Jhalarwan), 26° 44′ N, 65° 22′ E., about 2,600 ft. (no.M 298) ; near Iskalku, 7 miles E. of Kalat, 7,500 ft. (no. 91) ; Kalat, about 6,350 ft. (no. M398).— Fl. and fr. from April to Aug. 1918.

Vern. Name: Mariro (Br.), Lularo (Bal.).

Chenopodium hybridum *Sp. Pl. 219.*—Loc : Awaran Fort, 4 miles N. of Rekin, Kolwa, about 1 800 ft. (M245A); Harboi, 18 miles ESE of Kalat, 9,000 ft, (No. 77),— Fl. and fr. in April 1918 and Aug. 1917.

Uses: It is said that men eat the leaves.

Vern. Name: Kodalo (Bal.), Sirech (Br.).

Chenopodium murale *L. Sp. Pl. 219.*—Panjgur, about 3,200 ft. (no. M172); Turbat, 66° 4′ E, 25° 58′ N, about 600 ft. (no.M56).—Fl. and fr. in Feb. and March 1918.

Vern. Name: Kulpir (Bal. ?), Lalor (Sind).

BETA *L.*

Beta vulgaris *L. Sp. Pl. 222.*—Loc. Panjgur (no. M323).—Fr. in May 1918.

ATRIPLEX *L.*

Atriplex repens *Roth Nov. Sp. 377.*—Loc.: Panjgur (no. M148B); Khudabadan ¼ mile N of Panjgur, about 3,100 ft. (no. M148A); Sitani (Gidar), 59 miles S. of Kalat, 5,300 ft. (no. 117); Garrok (no. 325).—Fl. and fr. in May 1918, Aug. and Sept. 1917.

Vern. Name: Sorinchk (Bal.), Surinchk (Sarawan Br.), Gwaja (Jhalarwan Br.).

Atriplex Griffithi *Moq. in DC. Prodr. XIII, II, 102.*—Loc.: Harbud, about 50 miles E. of Panjgur, about 3,700 ft. (no. M313).

Uses : Said to be eatable.

Vern. Name: Magir (Br.).

KOCHIA *Roth.*

Kochia odontoptera *Schrenk in Bull. Acad. Petersb. I (1843) 361.*—Loc.: Panjgur, about 9,100 ft. (no. M174).

Vern. Name : Sorag (Bal.?).

Kochia sedo des *Schrad. Neues Journ. III (1809) III & IV, 85.*—Loc.: Kalat, 7,000 ft. (no. 1).

Uses Used as a medicine for worms. It is crushed in cold water and allowed to stand over night, and swallowed in the morning with some sweetmeat. (Hotson).

Vern. Name : Khisunshir. (Br.).

SUAEDA *Forsk.*

Suaeda nudiflora *Moq. in Ann. Sc. Nat. ser. XXIII, 316.*—Loc. Zahrenkahur 16 miles N of Pasni, about 200 ft. (no. M5B); Nodiz, 20½ miles W. of Turbat about 400 ft. (no. M5A); near Kalatak, 12 miles W. of Turbat, about 8,000 ft. (no. M5) Mazarjuh (Gidar, Jhalarwan), 28° 11′ N, 66° 2′ E. about 5,200 ft. (no. M5C); near Bazdad, about 25 miles E of Chamba (Kolwa), about 1,850 ft. (no. M5 cbis).

Vern. Name: Rigit (Bal. Br.).

Suaeda monoica *Forsk. Fl. Aeg. Arab. 70.*—Loc.: Las Bela, about 700 ft. (no. 164C); 27 miles N. of Ornach, about 3,400. (no. 188A); Teghab, 107 miles S. of Kalat, about 4,150 ft. (no. 188).

Vern. Name: Trat, Lana ; Right (Bal., Br.).

Suaeda physophora *Pall. III. 55, tab. 43.*—Loc.: NE of Hoshap, about 60 miles ENE of Turbat 2,000 ft. (no. M32); Gwambuk, about 50 miles SE of Panjgur, about 2,700 ft. (no. M26).—Uses : Good sheep-grazing.

Vern. Name: Sorag, Lundo (Bal.).

HALOXYLON *Bunge.*

Haloxylon recurvum *Bunge. in Boiss. Fl. Or. IV. 949.*—Loc.: Chakul, 11 miles WSW of Panjgur, about 2,900 ft. (no. M 27B); Guambuk, about 50 miles SE of Panjgur, 2,700 ft. (no. M27).—Uses: Good sheep-grazing.

Vern. Name: Gwantih (Bal.).

Haloxylon salicornicum *Bunge in Boiss Fl. Or. IV. 949.*—Loc.: Nag (W. Kolwa), about 83 miles E. by N. of Turbat, about 2,300 ft. (no. M71A); 5 miles N. of Mand, about 1,000 ft. (no. M71); Bhani, 131 miles SSW of Kalat, 4,000 ft. (no. 164A); Hazarganj, 27° 28′ N, 66° 12′ E, about 3,600 ft. (no. 329); near Kanoji, 47 miles N. of Las Bela, about 3,700 ft. (no. 164B); Chhuttok, 90 miles S. of Kalat, about 4,550 ft. (no. 164).—Fl. and fr. in Sept. and Oct. 1917.

Vern. Name: Trat Bal. Br. and Serawan Br.) Laragh (Bal.), Larch (Br.), Lana (Jhalarwan Br.).

Haloxylon articulatum *Bunge in Mem Sav. Etr. Petersb. VII (1851) 468.*—Loc.: NE of Hoshap, about 60 miles ENE of Turbat, 2,000 ft. (no. M33).

Vern. Name: Landen (Bal.).

Haloxylon Griffithii *Boiss Fl. Or. IV, 950.*—Loc.: Kalat, 7,000 ft. (no. 94); Sitani (no. 118); Pishuk, 27° 32′ N, 66° 18′ E, about 5,300 ft. (no. M340); Bennchah, 21 miles N. of Surab (Jhalarwan), about 6,200 ft. (no. M34B); Surab 28° 29′ N, 66° 16′ E., about 5,700 ft. (no. M34A).—Fl. and fr. in July 1918, Aug. 1920).

Vern. Name: Bundi (Bal. and Br.)

SALSOLA *L.*

Salsola Kali *L. L. Sp. Pl. 222.*—Loc.: Sitani (Gidar), 59 miles S. of Kalat 5,300 ft. (no. 116); near Manguli, 197 miles SSW of Kalat, about 2,450 ft. (no. 241); Surab, 28° 29′ N, 66° 16′ E., about 5,700 ft. (no. M366B); Wad 27° 20′ N, 66° 20′ N, 66 20 E, about 4,000 ft. (no. 116B),—Fr. in June 1918, Oct. 1917.

Vern. Name: Jaghun, Soreh, Kalbahi (Br.), Kalbahi (Jharwan Br.), Jaghun (Sarwani Br.).

Salsola foetida *Del. Fl. Aegoypt. 57.*—Loc.: 4 Zarjuh (Gidar, Jhalarwan) 28° 11′ N, 66° 2′ E, about 5,200 ft. (no. M357); Shire-zapatk, 27° 46′ N, 65° 37′ E, about 4,200 ft. (no. M32D); Chakul, about 11 miles WSW. of Panjgur, about 2,900 ft. (no. M32A); Sor (Kilkaur) 74 miles S. of Panjgur, about 2,300 ft. (no. M216); Rekchah, 11 miles E. of Chamba (Kolwa), about 1,800 ft. (no. M37B).—Fl. in March and April 1918.—Fr. in April 1918.

Vern. Name: Kahsakuni, Hasha (Br.), Hanshag (Bal.), Sorag, Sorago (Bal. and B.).

GIRGENSOHNIA *Bunge.*

Girgensohnia oppositifolia *Fenzl*, in Ledeb. Fl. Ross. III, 835.—Loc.: Kalat (no. M394A).

Vern. Name: Askkay.

ANABASIS *L.*

Anabasis annua *Bunge Anab. Rev. 46.*—Loc.: Gwambuk, about 60 miles SE of Panjgur, about 2,700 ft. (no. M27C).—Fr. in April 1918.

Vern. Name: Gwamich (Bal).

Polygonaceae.

CALLIGONUM *L.*

Calligonum crinitum *Boiss. Diagn. ser. 2, IV, 77.*—Loc.: Dokop, $10\frac{1}{2}$ miles E. of Mand, about 650 ft. (no. M60A); Tump, 46 miles W of Turbat, about 600 ft. (no. M60); Garmkan, 1 mile NE of Panjgur about 3,125 ft. (no. M60A).—Fl. & Fr. in March 1918.

Vern. Name: Pogh (Bal. and Br.).

PTEROPRYUM *Jaub & Spach.*

Pteropyrum Oliveri *Jaub & Spach III. Pl. Orient. II, 9, t. 108.*—Loc.: Tump, about 48 miles W. of Turbat about 600 ft. (no. M7); Rodkan (W. Kolwa) about 85 miles E. of Turbat, about 1,800 ft. (no. M34B); Bennchah, about 21 miles N. of Surab (Jhalarwan), about 6,200 ft. (no. E7B); Chhuttok, about 90 miles S. of Kalat, about 4,550 ft. (no. 160); Sor (Kilkaur), about 74 miles S. of Panjgur, about 2,300 ft. (no. M7A); Korak (Pelar), 180 miles SW of Kalat, 1,900 ft. (no. 160A).—Fl, in April 1918, July 1918, Aug. and Sept. 1917. Fr. in April 1918. Sept. 1917.

Vern. Name: Karawan Kush (Br. and Bal.), Mazhong, Mazhonk, Mazag (Bal.).

POLYGONUM *L.*

Polygonum polycnemoides *Jaub & Spach, III. Pl. Orient. II, 30, t. 120.*—Khudabadan, $\frac{1}{4}$ mile N. of Panjgur, about 3,100 ft. (no. M169A); Panjgur about 3,100 ft. (no. M169). Fl. in March 1918. Uses: Eaten with milk by poor people. (Hotson).

Vern. Name: Sirenchk (Bal. and Br., Hararish (Bal.).

Polygonum plebejum *Br. Prodr. 420.*—Loc.: Mohthai Kand, about 22 miles SW. of Panjgur, about 2,800 ft. (no. M131, M131A); Harbud about 55 miles E of Panjgur, about 3,700 ft. (no M169C).—Fl. and fr. in March and April 1918.

Vern. Name: Meshirhe, Hararish, Haranres (Bal.), Sirenchk, Sironch (Br.).

Polygonum persicaria *L. Sp Pl. 361.*—Loc.: Quetta.

Polygonum barbatum *L. Sp. Pl. 362.*—Loc.: Zidi, 15 miles ESE of Khozdar, about 3,600 ft. (no. 356).—Fl. in Sept. 1917.

Vern. Name: Kaba (Br.).

Polygonum aviculare *L. Sp. Pl. 362.*—Loc.: Sprin in Harboi, 19 miles ESE of Kalat, 8,800 ft. (no. 79).—Fl. and fr. in Aug. 1917.

RUMEX *L.*

Rumex vesicarius *L. Sp. Pl. 336.* Loc.: Ispikan, 16 miles NE of Mand, about 1,050 (no. M81); Kulbar Valley, some 25 miles ENE of Mand, about 1,300 ft. (no. M105).—Fl. in March 1918.

Vern. Name: Trushpanko (Bal.).

Rumex dentatus *L. Mant.* II. 226.—Loc.: Nag, (W. Kolwa), about 83 miles E by N of Turbat, about 2,300 ft. (no. M243) Khudabadan, $\frac{1}{4}$ mile N. of Panjgur (no. M196).—Fl. and fr. in March and April 1918.

Thymelaeaceae.

Dephne *L.*

Daphne oleoides *Schreb Ic. desc Pl. Decad I,* 13 *t. 7.*—Loc.: Kalgali Kaur (no. M349B); Gidar Dhor, about 85 miles S. of Kalat, about 4,700 ft. (no. 159); Wahir, 25 miles S. by W. of Khuzdar, about 4,200 ft. (no. 47D); Harboi, 18 miles ESE of Kalat, 9,000 ft. (no. 47B); under Harboi, 16 miles ESE of Kalat, 8,400 ft. (no. 47); Chhuttok, 90 miles S. of Kalat, about 4,550 ft. (no. 167). Fl. in June 1918, Aug. and Sept. 1917.—Fr. in Sept. 1917.

Uses: Poisonous to camels, horses and men. They say that when a camel eats it, his limbs become weak, he falls to the ground and rolls in pain, with profuse flowing from the mouth, nose and eyes. Although poisonous to other animals, it is (like oleander) eaten by goats without harm. The leaves are crushed and mixed with ata and oil to make a poultice for boils, etc. (Hotson).

Vern. Name: Pipal, Kirkotonk (Br.). Zaitun.

Elaeagnaceae.

Elaeagnus *L.*

Elaeagnus hortensis *M. Bieb. Fl. Taur. Cauc. II, 112.*—Loc.: Shahdadzai, 78 miles S. of Kalat, 5,000 ft. (no. 149).

Vern. Name: Sinjad (Br. etc.).

Euphorbiaceae.*

Euphorbia *L.*

Euphorbia granulata *Forsk Fl. Aeg. Arab. 94.*.—Loc.: Ispikan, 16 miles NE of Mand, about 1,050 ft. (no. M74); Awaran (Kolwa), 26° 24′ N, 65° 12′ E, about 1,750 ft. (no. M74b).—Fr. in March 1918.

Vern. Name: Meshir (Bal. and Br.).

Euphorbia ? neriifolia *L. Sp. Pl. (1753) 451.*—Specimen scrappy.-Loc.: Hills S. of Chamba (Kolwa), about 26° 9′ N, 64° 42′ E, about 1,800-2,300 ft. (no. M249).—Fl. and fr. in April 1918.

Vern. Name: Dedar (Bal. and Br.).

Euphorbia helioscopia *L. Sp. Pl. 459.*—Loc.: Panjgur, about 3,100 ft. (nos. M143, M22B). Fl. and fr. in March 1918.

Vern. Name: Zahrichk—Gurbagund (Bal.).

Euphorbia turcomanica *Boiss. Cent. Euph. 13.*—Loc.: Shahdadzai, 72 miles S. of Kalat, 5,100 ft. (no. 139).—Fr. in Aug. 1917.

Uses: Is boiled and used as a medicine for gripes. (Hotson).

Vern. Name: Meshir (Br.).

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* We have to thank Mr. P. M. Debbarman of the Sibpur Botanic Gardens for kindly naming the Euphorbiacae.

Euphorbia densa *Schrenk, in Bull. Phys. Math. Acad. Petersb. III (1845) 308.*—Loc.: Kalat, about 6,350 ft. no. M314C); perhaps also a specimen from Harboi, 18 miles ESE of Kalat, 9,000 ft. (no. 41).—Fr. in July 1918.

Vern. Name: Lappar (Br.).

Euphorbia sanguinea *Hochst and Steud. ex Boiss in DC Prodr. XV, II, 35.*—Loc.: Kochau, 122 miles SSW of Kalat, 4,150 ft. (no. 139A).—Fl. in Aug. 1917.

Uses: When used for medicinal purposes it is prepared like "bhang". (Hotson).

Vern. Name: Meshir (Br.).

Euphorbia caeladenia *Boiss. Diagn., ser. II, IV, 81.*—Loc.: Wahir. 25 miles SW. of Khozdar, about 4,200 ft. (no. 101A).—Fr. in Oct. 1917.

Vern. Name: Lappar, Palhibahi (Br.).

Euphorbia striatella *Boiss in DC. Proder. XV, II, 152.*—Loc.: N. side of Kalgali Pass (Jhalarwan), about 28° 9′ N, 65° 56′ E, about 5,300 ft. (M 314A); Mazhmonk Valley, 11 miles E. of Kalat, 7,600 ft. (no. 83.).—Fl. in Aug. 1917, Fr. in June 1918.

Vern. Name: Palhidahi (Br., Karkikah (Kherani).

Euphorbia near cornuta *Pers. Syn. II, 17*—Loc.: Harbud, about 55 miles E. of Panjgur, about 3,700 ft. (no. M 114): Mohthai Kand, about 22 miles SW. of Panjgur, about 2,800 ft. (M 22A).—Fl. and fr. in March and April 1918

Vern. Name: Koro (Bal.), Pati Bahi (B.), Zahrithk (Ketchi Bal.), Koro (Hill Bal.), Gurdagund (Panjguri Bal).

PHYLLANTHUS *L.*

Phyllanthus sp.—Specimen scrappy.—Loc.: Manguli (Jhalarwan 26° 45′ N 65° 23′ E, about 2,600 ft. (no. M 294).—Fl. in April 1918.

CHROZOPHORA *Neck.*

Chrozophora verbascifolia *A. Fuss. Tent. Euph. 28.*—Loc.: Sitani (Sidar Jhalarwan), 28° 9′ N, 66° 5′ E, 5,300 ft. (no. M 368.); near Padigazu, 40 miles SSW; of Panjgur, about 3,000 ft. (no. M 21); Teghap, 107 miles S. of Kalat, 4,150 ft. (no. 182A)—Fl. and fr. in June 1918, Aug. 1917.

Uses: The leaves are crushed and soaked. The liquid gives a green (? blue, dye. (Hotson).

Vern. Name: Popatbahi, Kangerish (Br.). Nilb (Bal.).

Chrozophora tinctoria *A. Juss. Tent. Euphorb. 23, t. 7, f. 25.*—Loc.: Hills S. of Chamba (Kolwa), 26° 9′ N, 64° 42′ E, about 1,800-2,200 ft. (no. M 21B)—Fl. and fr. in April 1918.

Uses: A blue dye is made from the fruit. (Hotson).

Vern. Name: Nilo (Bal.).

(*To be continued*).

REVIEW

LIFE OF SIR JOSEPH DALTON HOOKER, O.M., G.C.S.I.*

Joseph Dalton Hooker, who was born in 1817, and died in 1911, was almost the last survivor of the great group, Darwin, Wallace, Lyell, Huxley, and he played an important part in the revolution of thought which they brought about in the nineteenth century. His unique knowledge of plants and their distribution contributed to the evidences for evolution, and he was Darwin's confident, his keen but friendly critic, and his ardent champion. One of his gifts to posterity was this contribution to the new movement; another was the gradual transformation of Kew from little more than a park to a national institution of world-wide importance, which work was begun by his father and completed by himself in spite of official indifference and even opposition. His third great gift is the written works he has left, especially the Genera Plantarum (in which Bentham collaborated), the Index Kewensis, which was financed by Darwin as a gift to the nation, and his various floras with their instructive introductory essays.

Hooker's opportunities of studying plants were unrivalled, owing to his Botanical expeditions in different parts of the world, and the collections in his charge at Kew; but they were opportunities often hardly won and beset with difficulties, and his tireless industry never brought him enough of this world's goods to make his work easy.

His first journey in 1839, when only twenty-two years old but already with a reputation as a botanist, was with Ross to the Antarctic; and as the objects of the expedition were to establish magnetic observatories at St. Helena, the Cape and Van Dieman's Land, to make observations at various oceanic islands, and then to determine, if possible the position of the South Magnetic Pole and generally to explore the Antarctic regions, Hooker had opportunities for collecting plants from many localities. His equipment was of the scantiest, Government supplying him with nothing but drying-paper and some collecting-cases; the only glass bottles available were empty pickle bottles, and the only preservative rum from the ship's stores. Fortunately his father had given him microscopes and books, and though at first he had to wait to arrange his collections after an expedition ashore until his messmates were in bed, Capt. Ross soon provided space and a cabinet in his own cabin, where however damp and cockroaches had to be contended with, and in rough seas the microscope had to be lashed to the table. In spite of all difficulties, young Hooker collected assiduously, and scarcely needed his father's letters urging him to stick to his work and avoid unnecessary entertainments; this stern parent thought it a frivolous amusement to join a riding excursion in Madeira to see an ancient crater in the heart of the mountainous island.

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* Life and Letters of SIR JOSEPH DALTON HOOKER, O.M., G.C.S.I. Based on materials collected and arranged by Lady Hooker. By Leonard Huxley. *2 Vols. VII and 546, and VIII to 569 pp. London, John Murray, 1918.*

The luxuriant plant life in Madeira was a great joy to him; yet he was no less happy in desolate Kerguelen's Land. As a small child he used to look at a picture of this place, when sitting on his grandfather's knee and turning over the beloved pages of Cook's Voyages. The picture showed a strange arched rock, and the sailors killing penguins; and he thought he would be the happiest boy alive if ever he could see that wonderful rock and knock penguins on the head. The island is storm-swept, and the hill-tops were always covered with ice and snow, the vegetation is scanty, consisting largely of cryptogams, but Hooker collected every day of the two months' stay, and exclaims in a letter home: "You cannot conceive the delight which the new discoveries afforded as they slowly revealed themselves, though in many cases it was all I could do to collect from the frozen ground as much as would serve to identify a species . . . . Many of my best little Lichens were gathered by hammering out the tufts or sitting on them till they thawed." Lichens painted the rocks from the water's edge to the summit of the hills. And there they appeared like a miniature forest growing on the flat rocks: one was of a delicate lilac colour, another bright yellow, and another tinged whole caves near the sea with a light red. Much interest was taken in the so-called Kerguelen Cabbage (*Pringle's antiscorbutica*) discovered by Cook and eaten to prevent scurvy: Hooker grew it from seed and planted it on the Falkland Islands elsewhere.

At St. Helena he was greatly interested in what was afterwards called "the struggle for existence" between the native and imported plants and animals.

Arriving at Cape Horn just as winter ended, he thought the climate had been much abused, for spring came with a rush in ten days: "the Berberry flowered with bright golden blossoms, the tufts of Misodendrons on the beeches grew quite brilliant, and the crumply-leaved beech burst at every twig, emitting a delicious resinous smell." But in a few days snow came down, and thence forward clouds and fogs, rain and snow, justified all Darwin's descriptions (in the Voyage of the Beagle) of the dreary Fuegian summer.

Within the Arctic Circle, Hooker dredged for sea-animals and made drawings and studies of them, as there was no work for a botanist. Even a seaweed was only found here once, and at Cockburn Island one sole lichen was found, painting the rocks with red and orange,—a lichen which is abundant also in the Arctic regions. Hooker was destined to find it again, to his surprise, at 19,000 ft. in the Himalayas, where "my most Antarctic plant, *Lecanora miniata*" forms once more the only vegetation at an extreme limit of vegetable life, and stains the rocks so as to show them orange-red at a distance of five miles, exactly as on Cockburn Island.

Although unable to reach the position of the South Magnetic pole, Capt. Ross discovered the great Barrier and the sea which bears his name, and the members of his expedition were the first to see the wonderful volcano named after his ship Erebus.

Hooker's letters on this expedition show how much more he was than a collector and systematist, for he was constantly considering the significance of the facts he noted, especially the distribution of the species; and his *Flora Antarctica* and the separate floras of New Zealand, Tasmania, and Australia, etc., which he afterwards published suggest far-reaching problems. He was impressed with the idea that there must have been an ancient southern continent from which forms had spread to places now so disconnected as New Zealand and Chili, where

the same genera and even species are found. Another outstanding fact, for which he was not prepared, was the way in which his species from different regions run into one another, for he naturally at this time accepted the belief of his day that they were all fixed and distinct. His work therefore prepared him to accept Darwin's view when known, yet his native caution and critical spirit made him slow to adopt it, and at first he merely accepted it as a working hypothesis, giving scope for reason and reflection, and hopes of a rational explanation of the origin and dispersal of species, whereas "the old stick-in-the-mud doctrines of absolute creations, multiple creations, and dispersion by actual causes under existing circumstances are all used up, they are so many stops to further inquiry: if they are admitted as truths, why there is an end of the whole matter." The *Flora of New Zeland* was based on the old principle, but when the Tasmanian Flora was published he had whole-heartedly adopted the new.

Hooker's second and most important botanical journey, after the Antarctic expedition, was to the Himalayas. On his way out to India, when stopping at Cairo, he made a trip into the desert, that he might make some observations on its temperature and dryness, in order to see how near the starving and burning point vegetation would exist, in comparison with his many observations in the Antarctic of how much cold they would bear.

The story of his experiences in India has been told in his Himalayan Journals, his delight in the wealth of beautiful plants in the mountain jungles, his difficulties in collecting and preserving in monsoon weather, his native collectors and the elephant that gathered inaccessible plants for him, his imprisonment and ill-treatment by a hostile Dewan. Many of his specimens were lost or spoiled, but hundreds of cases reached safety. The rhododendrons required a book for themselves which was finely illustrated and edited by his father. At 18,000 ft., where no other known shrub grows, he discovered the little *Rhododendron nivale* with matted branches straggling on the ground, small scented leaves and purple flowers, struggling successfully against the rigours of the climate —scorching sun followed by keen frost at night, utter drought followed by extreme moisture, short time for blooming and few insects to help in fertilisation. His vivid description makes one regret more keenly than ever that one who could write thus sympathetically of plants should have been obliged to cut down the *Flora of British India* to so bare a description of each species. The volume brought out with the co-operation of his friend and companion Thomson, had an Introduction of 280 pages, and an equal amount of description, extending only from Ranunculaceace to Fumariaceae; but the East India Company refused any assistance, and the authors were so much out of pocket by their venture that it was impossible to continue the work on the same scale. Fifteen years after, in 1870, the India Council was moved to take an interest in the matter, and for twenty-seven years Hooker worked at the *Flora*, with help of various collaborators, and utilizing the collections of Wight, Falconer, Griffith, Wallich and others for all the districts of India not visited by himself. The last three volumes of the seven were brought out after his retirement from Kew, and to the end of his long life he continued to work at Indian botany, which he loved, revising the Indian balsams, and comparing them with African and Chinese balsams, delighted to find when over 90 years of age that "eyes and fingers are good as ever".

The F. B. I., he calls a pioneer work merely, and often expressed a great wish to see India properly botanized. The specimens from which he

worked were often badly preserved, badly mounted, and without notes, even of the colour of the flowers. He insisted much upon the necessity for observation in the field. Comparing the Indian with the Australian flora, he remarked that many typical forms from the Indian tropics exist in Australia, but no Australian plants seem to have found their way to India, although the eucalyptus flourishes when planted on Indian soil.

After his return from India, Joseph Hooker became his father's assistant at Kew, and it was not until 1860 that he undertook another botanical expedition. This was to Palestine and the results of his travels there were afterwards condensed into a masterly sketch of the Botany of Syria and Palestine for Smith's Bible Dictionary. His chief ambition was to ascend Mount Lebanon and examine the Cedars, comparing them with the Indian deodars. He found them decadent, no seedling being apparently able to survive the present dry climate, so that all the existing trees were from 50 to 500 years old. At 3,000 to 4,000 feet, he found the Lebanon scenery "Tibetan and wretched", and above 8,000 feet, the vegetation was extremely scanty. There was but one alpine or arctic plant, *Oxyria reniformis*, and that grew only at the summit and was very rare: he concluded that this indicates the same change of climate as is shown by the cedars, and that other arctics which probably existed there in earlier times when the climate was more moist have been expelled by the increasing drought. Their absence is characteristic of the mountains of Asia Minor also and of Morocco as Hooker himself found later. The Cedars of Lebanon he strongly held to be of the same species as the Indian Deodars, these being two extreme forms of one extinct type and their difference of habit due to the contrasted climates of dry Lebanon and humid Himalaya, especially as he had seen the two forms growing side by side at Dropmore and looking quite alike. His paper on the whole genus includes observations on the Cedars of Algeria, Lebanon, the Taurus, and India.

Eleven years later, in 1871, Hooker went to botanize in Morocco, looking forward to "tasting the delights of savagery again", and fufilling another childish ambition, inspired by Mungo Park's Travels, of ascending the Great Atlas. He found it politic to pose as the *hakim* and gardener of the Great Sultana Victoria, and the people believed he was searching for a herb which would enable her to live for ever! Here the labour of collecting and of drying in the moist atmosphere, would have been "almost intolerable. but for the compensating pleasures". Often his collaborator Ball would work by their one candle till about 2 a.m., and then Hooker would take up the task until morning. He decided that the flora of the Atlas was the dying out of the European flora, and the difference on either side of the Straits of Gibraltar emphasised the antiquity of the severance.

Hooker's last botanical expedition, undertaken at the age of sixty, was made in company with Asa Gray, who was five or six years older, but the two elderly botanists were indefatigable in their survey of the North American flora, although their journey from East to West included an ascent of a peak 14,500 feet high in the Rockies, where for five hours they had to force their way through thick forest, and a ten days' wagon journey across the Sierra Nevada to the Yosemite Valley. The two problems which they were most anxious to solve were Gray's of the connection between the plants of the Eastern States with those of East Asia and Japan, and Hooker's of the hard line of division between the Arctic flora of America and Greenland. They agreed that both might have resulted from a glacial period and a former connection with an Arctic continent. The warm-climate types of plants now found in North Polar regions as fossils had

been pushed south by the advancing ice into America as well as Asia, and had found congenial sites in the forest area of the east coast of America, but the ice-cap remaining long on the Rockies, had prevented these plants from settling there except in some favoured localities, while the desert region which developed in the middle of the continent prevented the eastern plants from re-invading the Rockies, which were eventually peopled largely from Mexico. With regard to Greenland, Hooker believed that the advance of the ice-cap there had pushed the plants into the sea, so that there could be no return for them, and nore-peopling from elsewhere, hence the paucity of the Greenland flora. He was inclined to accept Buffon and Saporta's view that vegetable life may have begun at one of the poles, because these would be the first regions to become cool enough to support life, and the balance of evidence seemed to him to point to the north pole, because distribution has apparently flowed in general from north to south, as already noted with regard to India and Australia. Scandinavian types are very widely distributed; and old types, such as cycads and Proteaceae have perhaps reached the southern hemisphere in quite recent geological times, while becoming almost extinct in the north.

After this journey in America, Hooker had botanized in all the continents of the world, as well as on many oceanic islands. Yet these expeditions formed the smallest part of his life-work: for the greatest part he was at Kew, where he worked up not only his own collections but those of others. He published a Flora of the Cameroons, wrote on the Galapagos, plants, and on the distribution of Arctic Plants. The immense herbarium was gradually brought into order and constantly added to, the gardens were improved, and new buildings added; he was always ready to make observations and experiments for Darwin on the structure of orchids, the habits of carnivorous plants, etc., and he took a great interest in the economic botany of the Empire. In the 70's there was a great demand for eucalyptus trees to combat malaria, and many were supplied from Kew: to Hooker was due the importation of rubber, of which he foresaw the importance, into Ceylon, Fiji, Australia, Java, and Zanzibar; Liberian coffee first grown at Kew became a flourishing crop in the East and West Indies; chocolate was introduced into Ceylon, cinchona established in India, and various fodder grasses were taken to new centres. The cigar industry in Jamaica was due to Hooker, and together with other crops, such as cinchona and fruits, rescued the island from bankruptcy when the sugar industry failed. Hooker's advice was that small cheap botanical gardens, for economical plants only, should be started in all our colonies.

After being Sir Willian Hooker's assistant at Kew from 1855, Sir Joseph naturally stepped into his father's place when the latter died, and was Director of Kew from 1865 to 1885. On his retirement, a private letter from Lord Iddesleigh expressed the opinion that Kew would be to Joseph Hooker what St. Paul's was to Wren. Sir Joseph sent thanks in the name of his family, so as to include his father, to whom he was always loyal by devoted, and in a letter to a friend be acknowledges that "Kew is what my father and I have made it by our sole unaided efforts." His influence on botanical science was felt in many ways, especially as he was member of many scientific and learned societies, and President of the Royal Society. He retired only to work harder than ever at his plants, freed from the administrative and offiicial duties of his position at Kew.

Although he was twice married, none of Hooker's children became botanists, but his daughter's husband, William Thistleton-Dyer, who had been his private secretary, succeeded him as Director at Kew.

The two stout volumes from which this brief account is taken, are interesting throughout, and seem to make one really acquainted with a rare and delightful personality. One realizes his passion for plants from first to last, an inheritance from both his father and his mother's father, Dawson Turner; and his development can be traced, from the reserved puritanical youth who shuns society and refrains from collecting plants on Sundays, to the genial host at Kew and the correspondent of Darwin, full of fun and broad modern views. A chapter by Prof. Bower summarizes admirably Sir Joseph Hooker's position as botanist. In two appendices are given a complete list of his writings, and the long roll of honours and appointments conferred upon him. The illustrations are all well chosen, and include six portraits of the botanist at different periods, and two pictures of his camp life, one in Sikkim, with his Lepcha collectors and Gurkha guard, and one in the Rockies with Asa Gray and other American friends. A welcome feature of the book is a brief biographical notice in a footnote of each notable person mentioned in the text, and there is a good index.

M. A. EVERSHED.

Printed and Published for the Proprietor by J. B. BUTTRICK at the Methodist Publishing House, Mount Road, Madras.

THE

Journal of Indian Botany.

VOL. I. MAY, 1920. Nos. 9 & 10.

THE PHYSIOLOGICAL ANATOMY OF THE PLANTS OF THE INDIAN DESERT

BY

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(*Continued from p. 247.*)

LYTHRACEAE—(*Contd.*)

The mesophyll is composed of palisade tissue on the upper side and of arm-palisade tissue on the lower. Internal secretory organs are not found. Oxalate of lime occurs in the form of clustered crystals near the veins in *A. desertorum.*

The veins are embedded and are enclosed in green bundle-sheaths.

Hairy covering is found on the axis and on the upper surface of the leaf of *A. desertorum* and consists of unicellular conical hairs with verrucose walls and sometimes seated on a group of two or three epidermal cells (fig. 126). Glandular hairs are not found.

Structure of the Axis :—The epidermis is composed of tabular cells with outer walls thickened, verrucose and convexly arched outwards. The inner walls are thickened; and the lateral walls are thin and straight. The axis is ribbed at the angles. The cortex is composed of chlorenchyma extending to the ribs.

The pericycle forms a loose ring of bast fibres, those in *A. baccifera* having thin walls and large lumina. The wood is composite. The vessels are uniformly distributed in incomplete rows, vessels becoming larger towards the inner margin of the wood. The interfascicular wood prosenchyma is composed of cells with thin walls and large lumina and is more extensive in the upper half. The medullary rays are uniseriate and numerous. Wood parenchyma is abundantly developed at the inner margin of the wood cylinder.

The pith is composed of thin-walled cells and is characterised in *A. baccifera* by small groups of thick-walled cells, having the same size and shape as that of the pith cells. These cells form probably the strengthening tissue of the pith.

ONAGRACEAE

Trapa bispinosa *Roxb.*—Fig. 127. *Leaf only.*—Epidermis formed of tabular cells with outer walls very greatly thickened on the upper surface. Stomata occurring only on the upper surface. Clothing hairs in the form of uniseriate trichomes and found only on the lower surface. Mesophyll formed of palisade tissue on the adaxial side and of spongy tissue on the abaxial side. Spongy tissue characterised by large intercellular spaces. Oxalate of lime found in the form of numerous clustered crystals. Veins embedded and not provided with bundle-sheaths.

Structure of the Leaf.—The epidermal cells are tabular and thin-walled on the lower surface. The outer walls of the epidermal cells on the upper surface are very greatly thickened. The lateral walls are straight. Stomata occur in large number only on the upper surface and are surrounded by ordinary epidermal cells. Guard-cells are situated in the plane of the surrounding cells and the front cavity is on a level with the surface. Closure of the stomata seems to take place by the well developed cuticular ridges of the guard-cells (fig. 127).

Hairy covering consists of long uniseriate thin-walled trichomes occurring only on the lower surface (fig. 127). External glands are not found.

The mesophyll is composed of long-celled palisade tissue on the adaxial side and of spongy on the abaxial side which is characterised by large intercellular spaces. The system of large intercellular spaces helps the leaves to float on the surface of water.

Internal secratory organs are not found. Oxalate of lime occurs in the form of numerous clustered crystals in the spongy tissue. The cells containing clustered crystals are arranged in small groups projecting into the intercellular spaces. Larger clustered crystals are isolated and occur in the palisade tissue.

The veins are embedded and are not enclosed in bundle-sheaths.

CUCURBITACEAE

Momordica dioica *Roxb.*—Figs. 128, 129, 130. 131. Leaves membraneous. Guard-cells elevated. Mesophyll formed of short-celled palisade tissue on the upper side and of spongy tissue on the lower. Trichomes on the leaf provided with subsidiary cells not

elevated above the base of the trichomes. Cystolith-like structures not found in the basal cells of the trichomes. Branches deeply furrowed. Pericycle forming a continuous undulated ring of stone-cells. Collenchyma developed in the angles.

Cucumis Melo *L.*—Figs. 132, 133, 134. Guard-cells elevated above the epidermis. Mesophyll composed of short-celled palisade tissue on the adaxial side and of spongy tissue on the abaxial side. Trichomes on the leaves provided with subsidiary cells not raised above the base of the trichomes. Axis obtusely angular with stiff long trichomes on the ridges. Collenchyma forming a continuous undulated ring below epidermis. Cystolith-like structures in the basal cells of the trichomes on the leaf. Some of the cells of soft bast as well as some of those of the ground tissue, separating the vascular bundles, with tanniniferous contents. Pericycle forming a continuous ring of stone-cells.

Citrullus Colocynthis *Schrad.*—Figs. 135, 136. Guard-cells much elevated above the epidermis. Mesophyll formed of long-celled palisade tissue on the adaxial side and of arm-palisade tissue on the abaxial side. Trichomes on the leaf provided with subsidiary cells raised above the base of the trichomes. Cystolith-like structures found in the basal cells of the trichomes on the leaf. Groups of colourless palisade-like cells below the lower epidermis forming water-cells. A few cells of soft bast with tanniniferous contents. Axis not much angled. Pericycle formed of closely placed groups of stone-cells. Collenchyma developed in the larger angles.

Melothria maderaspatana *Cogn.*—Figs. 137, 138. Guard-cells much elevated above epidermis in the leaf; and situated on a pedestal on the axis. Mesophyll formed of long-celled palisade tissue on the adaxial side and of spongy tissue on the abaxial side. Trichomes on the leaf provided with subsidiary cells not much raised above the base of the trichomes. Cystolith-like structures found in the basal cells of the trichomes. A few cells of soft bast with tanniniferous contents. Pericycle forming a continuous undulated ring of stone-cells. Axis deeply furrowed. Collenchyma developed in the ridges.

Structure of the Leaf.—The epidermis consists of polygonal cells with outer walls a little thickened. The lateral walls are undulated. Cystolith-like structures occur in the basal epidermal cells of the trichomes on the leaf except in *Momordica dioica.* The stomata are more numerous on the lower surface and are surrounded by ordinary epidermal cells. The guard-cells are elevated. The front cavity i placed in a depression formed by the outer thickened epidermal walls in species of *Citrullus*; in species of other genera it is situated on a

level with the surface. The stomata on the axis are found at the apex of pedestals formed by epidermal cells. The pedestals are quite conspicuous in *Melothria maderaspatana* (fig. 138).

The mesophyll is composed of palisade cells, which are much shorter in *Momordica dioica* and *Cucumis Melo*, on the adaxial side and of an extensive spongy tissue on the abaxial side. The spongy tissue is replaced by arm-palisade tissue in *Citrullus Colocynthis*. There are groups of colourless palisade-like cells below the lower epidermis of *Citrullus Colocynthis*; these groups of cells may form water-cells.

The veins are embedded and are not provided with bundle-sheaths. They are vertically transcurrent.

The hairy covering consists of clothing and glandular hairs. The clothing hairs are more numerous on the lower surface and consists of simple uniseriate thin-walled trichomes seated on subsidiary cells which are raised above the base of the trichomes in *Cucumis Melo* (fig. 134) and in *Melothria maderaspatana*. The trichomes on the axis are accompanied by numerous subsidiary cells, which form a pedestal-like structure (fig. 132). The constituent cells of the trichomes are dilated at the base, thus giving them a somewhat jointed appearance.

The external glands on the leaf and axis are composed of a short uniseriate stalk usually placed in epidermal depressions and of an ovoid head divided by horizontal and vertical walls. Glandular hairs seem to be more numerous on the upper surface in *Momordica dioica*.

Structure of the Axis.— The epidermis consists of small polygonal cells with outer walls a little thickened. Axes are deeply five-grooved except in *Citrullus Colocynthis* where the ridges and the furrows are very slight.

The cortex is characterised by an assimilatory tissue formed of chlorenchyma. The collenchyma is sub-epidermal; it is developed in the angles in *Momordica dioica* and in *Melothria maderaspatana* (fig. 136); in *Cucumis Melo* it forms a continuous ring thickened in the angular portions. In *Citrullus Colocynthis* collenchyma is developed below the epidermis of the larger angles.

The pericycle forms a composite undulated ring of stone-cells except in *Citrullus Colocynthis* where it is composed of closely placed groups of stone-cells.

The vascular bundles are bicollateral and are arranged in two rings five in each ring. The bundles in the outer ring are much smaller and occur below the angles where they are conspicuous. Smaller bundles project towards the exterior and the larger towards

the interior. The bundles are connected together by broad strips of ground tissue which resemble medullary rays. Bundles in the inner ring almost meet in the centre in *Citrullus Colocynthis* and in *Melothria maderaspatana.* The vessels expecially those of the bundles of the inner ring have very wide lumina.

A few cells of soft bast on either side of the bundles hold tanniniferous contents in all members except *Momordica dioica.*

The pith is greatly reduced on account of the bundles of the inner ring projecting inwards. It consists of a few thin-walled cells.

General Review.—The epidermal cells have outer walls a little thickened. The mesophyll is bifacial. Stomata are usually elevated above the epidermis, much more so on the axis where they are usually situated at the apex of pedestals formed by the subsidiary cells. The stomata, as a rule, are more numerous on the lower surface of the leaf. The hairy covering consists of uniseriate thin-walled trichomes seated on subsidiary cells which, on the axis, are raised above the base of the trichomes in the form of a pedestal. The trichomes are somewhat jointed and more numerous on the lower surface of the leaf. Internal secretory organs are represented by a few isolated cells of soft bast with tanniniferous contents in all members except *Momordica dioica.* The glandular hairs are placed in epidermal depressions and consist of a short uniseriate stalk and of an oval head divided by horizontal and vertical walls. The pericycle forms a continuous and undulated ring of stone-cells or it is formed of closely placed groups of stone-sells. Collenchyma is developed below the epidermis of the angles. The vascular bundles are bicollateral and are situated roughly in two rings. The bundles of the outer ring are much smaller and are situated below the angles; bundles belonging to the inner ring are much larger and are placed below the furrows; smaller and larger bundles project outwards and inwards respectively. The bundles are separated from one another by broad strips of ground tissue resembling medullary rays. The vessels have wide lumina and simple perforations. The pith is greatly reduced as the bundles of the inner ring almost meet in the centre.

FICOIDEAE

Trianthema triquetra *Rottl. & Wild.*—Figs. 139, 140. Leaves fleshy. Mesophyll characterised by an extensive aqueous tissue. Stomata found only on the lower side of the leaf. Arcs of palisade cells on the lower side. Veins embedded and half enclosed with green bundle-sheaths. Clustered crystals found near the veins, in the cortex and in the pith. Some of the epidermal cells bladder-like and attenuated at the apices into hair-like structures. Axes angled. Wood

belonging to the second type. Groups of soft bast embedded in the wood cylinder. Pith formed of thin-walled cells.

Trianthema pentandra *L.*—Figs. 141, 142, 143. Some of the epidermal cells bladder-like and attenuated at their apices into hair-like structures. Mesophyll bifacial. Clustered crystals near the veins, in the cortex and pith. Veins provided with green bundle-sheaths. Branches angled and grooved. Sclerenchymatous pericycle not developed. Wood belonging to the second type. Pith formed of thick-walled cells.

Orygia decumbens *Forsk.*—Figs. 144, 145, 146, 147. Mesophyll composed of palisade tissue on the adaxial side and of arm-palisade tissue on the abaxial side. Veins not provided with bundle-sheaths. Clustered crystals found near the veins, in cortex and in pith. Axes obscurely angled. Assimilatory tissue in the axis formed of chlorenchyma. Collenchyma developed in the angles. Pericycle forming a composite ring of stone-cells. Wood belonging to the third type. Pith formed of thin-walled cells.

Mollugo hirta *Thunb.*—Figs. 148, 149, 150. Clothing hairs forming a dense covering of stellate hairs. Mesophyll isobilateral. Star-like bundles of acicular crystals in the mesophyll. Veins embedded and without bundle-sheaths. Assimilatory tissue formed of chlorenchyma. Clustered crystals found in the cortex and in the pith. Pericycle formed of a composite ring of stone-cells. Pith composed of thin-walled cells.

Mullugo nudicaulis *Lam.*—Figs. 151, 152, 153. Mesophyll bifacial. Styloids found in the spongy tissue. Veins embedded and without sheaths. Clustered crystals in the neighbourhood of the veins. Assimilatory tissue in the axis formed of chlorenchyma. Structure of wood belonging to the first type. Pith formed of thin-walled cells.

Mullugo Cerviana *Ser.*—Figs. 154, 155. Some of the epidermal cells larger and with water-storing function. Mesophyll isobilateral. Veins embedded and provided with green bundle-sheaths. Assimilatory tissue in the axis in the form of chlorenchyma. Sclerenchymatous pericycle forming a composite ring. Structure of wood belonging to the first type. Pith formed of thin-walled cells.

Gisekia pharnaceoides *L.*—Fig. 156. Leaves sub-fleshy. Mesophyll bifacial. Veins embedded and without bundle-sheaths. Bundles of acicular crystals found near the veins, in the cortex and in the pith. Axes angled. Sclerenchymatous pericycle forming a composite ring. Structure of wood belonging to the third type. Pith formed of thin-walled cells.

Limeum indicum *Stocks.*—Figs. 157, 158, 159. Some of

the epidermal cells large and having water-storing function. Mesophyll isobilateral. Clustered crystals found near the veins and in cortex. Hair-like structures, with walls thickened and superficially rugose, found on the leaf. Pericycle formed of rhomboidal groups of stone-cells, Pith formed of thick-walled cells.

Structure of the Leaf.—The epidermis consists of polygonal cells with outer walls thickened, papillose and superficially granulated, except in species of *Mollugo* in which the cells are very thin-walled. The thickening of the outer walls is considerable in *L. indicum* (fig. 157). Some of the epidermal cells in *T. pentandra* (fig. 114) are bladder-like and are attenuated at their apices into hair-like structures; they are numerous on the lower side of the mid-rib. There are also, in *M. Cerviana* and *L. indicum*, large cells intercalated amongst the epidermal cells of ordinary dimensions. All these specialised cells seem to have the function of absorbing and storing water. The lateral walls are thin and undulated.

The thinness of the outer walls, specially in *M. hirta* and *M Cerviana*, can be accounted for by the presence of a protective covering of dense stellate hairs and by the occurrence of large water-storing epidermal cells.

The stomata are usually numerous on both the surfaces of the leaf and are surrounded by ordinary epidermal cells. The front cavity is placed in a depression formed by outer thickened and papillose epidermal walls (figs. 145, 158). The stomata in *T. triquetra* (fig. 139) are elevated and occur only on the lower surface, owing to the occurrence of an extensive aqueous tissue on the upper surface. The guard-cells are usually elevated, though in *T. triquetra*, *T. pentandra* and in *M. Cerviana* elevated guard-cells occur side by side with guard-cells situated in the plane of the surrounding cells. The stomata are, as a rule, numerous and can be accounted for by the fleshy character of the leaf.

The mesophyll is isobilateral in *M. hirta* (fig. 150) and *M. Cerviana* (fig. 154), in other members it is bifacial. The mesophyll, in *T. Pentandra* (fig. 141), *M. nudicaulis* (fig. 151) and *G. pharnaceoides*, consists of palisade tissue on the upper side and of spongy tissue on the lower. The structure of the mesophyll in *T. triquetra* is characteristic; it consists on the abaxial side of a subepidermal aqueous layer and of arcs of palisade cells on the lower side of the veins and on the adaxial side of an extensive aqueous tissue of large polygonal cells. In *O. decumbens* and *L. indicum* (fig. 157) there is palisade tissue on the upper side and arm-palisade tissue on the lower.

Internal secretory organs are not found in the leaf and axis. Oxalate of lime occurs in the form of numerous large clustered cry-

stals in the neighbourhood of the veins in *T. triquetra*, *T. pentandra*, *O. decumbens*, *M. nudicaulis* and *L. indicum*. Besides clustered crystals near the veins, there are solitary ones in the spongy cells of *M. nudicaulis* (fig. 151). Palisade cells on both sides, in *M. hirta* (fig. 150) and *M. Cerviana* (fig. 154), contain small bundles of needle-like crystals and solitary crystals respectively. Oxalate of lime is found in the form of bundles of acicular raphides in *G. pharnaceoides*.

The veins are embedded in all members; they are provided with bundle-sheaths of green, thin-walled cells in *T. pentandra* and *M. Cerviana*. Sheath-cells are colourless in *L. indicum*. Veins in *T. triquetra*, are provided only on the lower side with arcs of green bundle-sheath cells, owing to the occurrence of the assimilatory tissue on the sides of the veins.

Hairy covering on the leaf and axis is found only in *M. hirta* and consists of stellate hairs with an uniseriate stalk and a star-shaped terminal cell (figs. 148, 149, 150). In *L. indicum* (fig. 157), there are papillae-like unicellular structures with walls thickened and superficially rugose. They may have been developed from epidermal outgrowths which were afterwards separated by transverse walls; they may have a water-storing function. External glands are found only in *L. indicum* in the form of capitate glandular hairs (figs. 157, 159).

Structure of the Axis.—The epidermis consists of polygonal cells with outer walls thickened. Lateral walls are thin and undulated Inner walls are also thickened in *T. triquetra*, *T. pentandra*, *O. decumbens*, *M. hirta* and *G. pharnaceoide*. There are large bladder-like cells, attenuated at their apices into hair-like structures, intercalated amongst epidermal cells of ordinary dimensions in *T. triquetra* (fig. 140) and in *T. pentandra* (fig. 143). These cells may have a water-storing function. The stomata are like those on the leaf.

The primary cortex is represented by a thin-walled parenchymatous assimilatory tissue in *O. decumbens* and in species of *Mollugo*. Collenchyma is developed in the angular portions of *O. decumbens*. The primary cortex, in other members, is formed of colourless cortical parenchyma.

The pericycle is formed of a more or less composite ring of stone-cells in *O. decumbens* (fig. 146), species of *Mollugo* (figs. 149, 153, 155) and *G. pharnaceoides*. In species of *Mollugo* the ring of stone tissue is very thick. The pericycle in *L. indicum*, consists of rhomboidal groups of stone-cells; in other members it is not sclerenchymatous, which is compensated for perhaps by extensive interfascicular wood prosenchyma which is very little developed in species of *Mollugo*. It seems, therefore, that the development of sclerenchymatous pericycle is inversely proportional to that of interfascicular wood prosenchyma.

The wood is composite in all members. In species of *Trianthema* it is composed of numerous xylem bundles which are embedded in interfascicular wood prosenchyma in more or less distinct concentric rings (figs. 140, 143). In species of *Mollugo* it is composed of large xylem bundles with vessels large and numerous and with little interfascicular wood prosenchyma (figs. 149, 153, 155). Vessels, in *O. decumbens*, *G. pharnaceoides* and *L. indicum*, are large and numerous and are uniformly distributed in the interfascicular wood prosenchyma. Thus the structure of the wood can be classified into three types—*M. nudicaulis* and *M. Cerviana* representing one type species of *Trianthema* another and *O. decumbens*, *M. hirta*, *G. pharnaceoides* and *L. indicum* the third type.

The structure of the wood has undergone modifications

(1) either due to the decumbent habit as in *O. decumbens* in which the wood cylinder is very much narrowed and the vessels are few and small on the lower side of the axis.

(2) or to the direction of the prevailing wind as in *T. triquetra*, *G. pharnaceoides* and *L. indicum*, in which larger xylem bundles with vessels larger and more numerous occur on two opposite sides of the axis which represent the plane of the direction of the prevailing wind, while in a plane at right angles to this occur much smaller xylem bundle with vessels much smaller and less numerous.

These modifications are the result of greater functional activity on those sides which are more affected by wind in the case of erect axes, or by the sun and wind together in case of prostrate axes.

The pith consists of thick-walled calls in *T. pentandra*, *M. hirta* and *L. indicum*; in other members it is formed of thin-walled cells.

Oxalate of lime is found in the form of clustered crystals in the cortex and pith of *T. triquetra*, *T. pentandra*, *O. decumbens* and *M. hirta*; in *L. indicum* clustered crystals occur only in the cortex. Acicular crystals are found in the cortex and pith of *G. pharnaceoides*.

Anomolous structures are represented by groups of soft bast embedded in the wood cylinder in *T. triquetra*.

General Review.—Epidermis consists of polygonal cells with outer walls usually thickened. Large bladder-like cells with water-storing function are intercalated amongst epidermal cells (figs. 141, 143). Stomata are depressed and are accompanied by ordinary epidermal cells. The mesophyll in *T. triquetra* (fig. 139) is characterised by an extensive aqueous tissue. Oxalate of lime is found in the form of clustered crystals in the leaf and axis of most of the members. Styloids occur in *M. nudicaulis* and *M. Cerviana;* acicular crystals are present in *G. pharnaceoides*. Hairy covering is present only an *M. hirta*

and consists of stellate hairs. There are unicellular papillae-like—structures in *L. indicum*, (fig. 157), with walls superficially rugose and perhaps with a water-storing function.

The pericycle is composed of stone-cells, except in species of *Trianthema*. Wood is composite and can be classified into three types as described already. The structure of the wood undergoes modifications either due to the prostrate habit of the axis or to the action of wind in case of erect axes. The perforations of the vessels are simple. The pith consists of thin-walled or thick-walled cells.

RUBIACEAE

Oldenlandia aspera *DC.*—Fig. 162. Epidermal cells with outer walls convexly arched outwards. Mesophyll formed of short-celled palisade tissue. Unicellular dome-like structures with thickened and muriculate walls found on the axis. Epidermal cells of the axis with both outer and inner walls thickened. Internal secretory organs and oxalate of lime not found. Sclerenchymatous pericycle absent. Soft bast of thick walled-cells. T: S. of the axis circular.

Spermacoce hispida *L.*—Figs. 160, 161. Upper epidermal cells larger and with outer walls usually toothed in the middle. Mesophyll composed of palisade tissue on the upper side and of spongy tissue on the lower. Internal secretory cells with tanniniferous contents numerous in the mesophyll. Secretory cavities found in the mesophyll and cortex. Acicular crystals found in the cortex. Clothing hairs in the form of articulated uniseriate trichomes. Epidermal cells of the axis with outer walls thickened. Axes quadrangular. Angles bearing wing-like ribs. Pericycle forming a loose ring of bast fibres.

Structure of the Leaf.—The epidermal cells are polygonal with the outer walls greatly thickened and convexly arched outwards. The outer walls of the upper epidermal cells of *S. hispida* are toothed in the middle, while those of the epidermal cells on both the surfaces in *O. aspera* are sometimes papillose. Lateral walls are thin and undulated; inner walls are thin.

The stomata are accompanied by subsidiary cells and are more numerous on the lower surface. The guard-cells are situated in the plane of the subsidiary cells which are elevated above the surrounding cells. The front cavity is placed in depressions formed by the outer thickened walls of the surrounding cells. The stomata on the axis have the same characters as of those on the leaf (fig. 162).

The mesophyll in *O. aspera* is composed wholly of short palisade cells; it is bifacial in *S. hispida*. Internal glands occur only in *S. hispida*, and are represented by mucilaginous secretory cavities

with acicular raphides (fig. 160) in the assimilatory tissue in the leaf and axis. Besides these, there are assimilatory cells in the mesophyll with tanniniferous contents (fig. 160 *G.*).

Oxalate of lime occurs only in *S. hispida* either in the form of acicular raphides in the mesophyll and pith (fig. 161 A. R.), or in the form of crystal sand in the cortex. The vains are embedded and are not provided with bundle-sheaths. Veins of the mid-rib are vertically transcurrent above and below by collenchyma in *O. aspera*.

The hairy covering on the leaf and axis in *S. hispida* (figs. 160, 161) consists of articulate uniseriate trichomes with the terminal cell ending in a sharp point; trichomes on the axis are situated in groups on the wing-like ribs at the angles (fig. 161). Trichomes are more numerous on the lower surface of the leaf. Clothing hairs are absent on the leaf of *O. aspera*; on the axis, however, there are peculiar dome-like unicellular hair-like structures with walls thickened and muriculate. Glandular hairs are not found on the leaf and axis.

Structure of the Axis.—The epidermis consists of tabular cells with outer walls greatly thickened. The outer walls are muriculate and the inner walls also thickened in *O. aspera* (fig. 162). The lateral walls are thin and straight. There are large wing-like ribs at the angles of the axis in *S. hispida.* The cortex of *S. hispida* is composed of parenchymatous assimilatory tissue extending into ribs which are strengthened by collenchyma. Assimilatory cells contain rounded bodies of the nature of fat bodies. Endodermis is differentiated. Sclerenchymatous pericycle is found only in *S. hispida* and is composed of a loose ring of bast fibres.

The vessels are arranged in complete rows and are larger in the lower half of the wood. Interfascicular wood prosenchyma is scantily developed and is formed of cells with thin walls and with large lumina. Medullary rays are uniseriate and numerous. The abundance of vessels and the scanty development of interfasicular wood prosenchyma are characteristic of the herbaceous nature of the plants.

The pith is composed of thin-walled cells.

(To be continued.)

Plate XV

128-131. *Momordica dioica.*
128. Hair on the leaf.
Oc. 4 Com.; Ob. 3 mm. Ap.
129. T. S. of the leaf showing the upper epidermis.
Oc. 4 Com.; Ob. 3 mm. Ap.
130. Glandular hair on the leaf.
Oc. 4 Com.; Ob. 3 mm. Ap.
131. Stoma on the lower surface of the leaf.
Oc. 4 Com.; Ob. 3 mm. Ap.

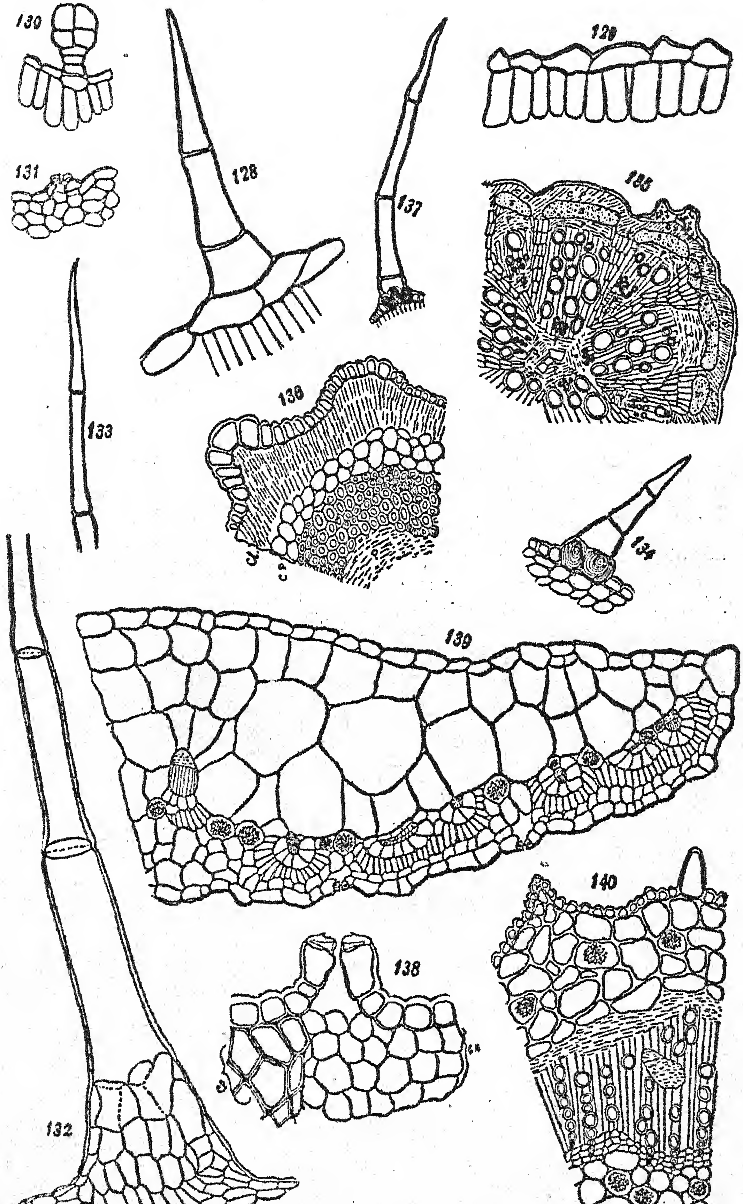
132-134. *Cucumis Melo.*
132. Lower portion of the hair on the axis removed by peeling off the epidermis.
Oc. 2 Com.; Ob. 8 mm. Ap.
133. Terminal portion of the same hair.
Oc. 2 Com.; Ob. 8 mm. Ap.
134. Hair on the leaf.
Oc. 6 Com.; 8 mm. Ap.

135-136. *Citrullus Colocynthis.*
135. T. S. of the axis.
Oc. 2. Com.; Ob. 16 mm. Ap.
136. T. S. of the axis showing the ribs.
Oc. 2 Com.; Ob. 3 mm. Ap.

137-138. *Melothria maderaspatana*
137. Hair on the leaf.
Oc. 2 Com.; Ob. 8 mm. Ap.
138. Stoma on the axis.
Oc. 6 Com.; Ob. 3 mm. Ap.

139-140. *Trianthema triquetra.*
139. T. S. of the leaf representing half of the leaf-blade including the mid-rib.
Oc. 4 Com.; Ob. 8 mm. Ap.
140. T. S. of the axis.
Oc. 6 Com.; Ob. 8 mm. Ap.

N.B.—To get the original dimensions multiply by 1·7.



T. S. Sabnis del.

PLATE XV.

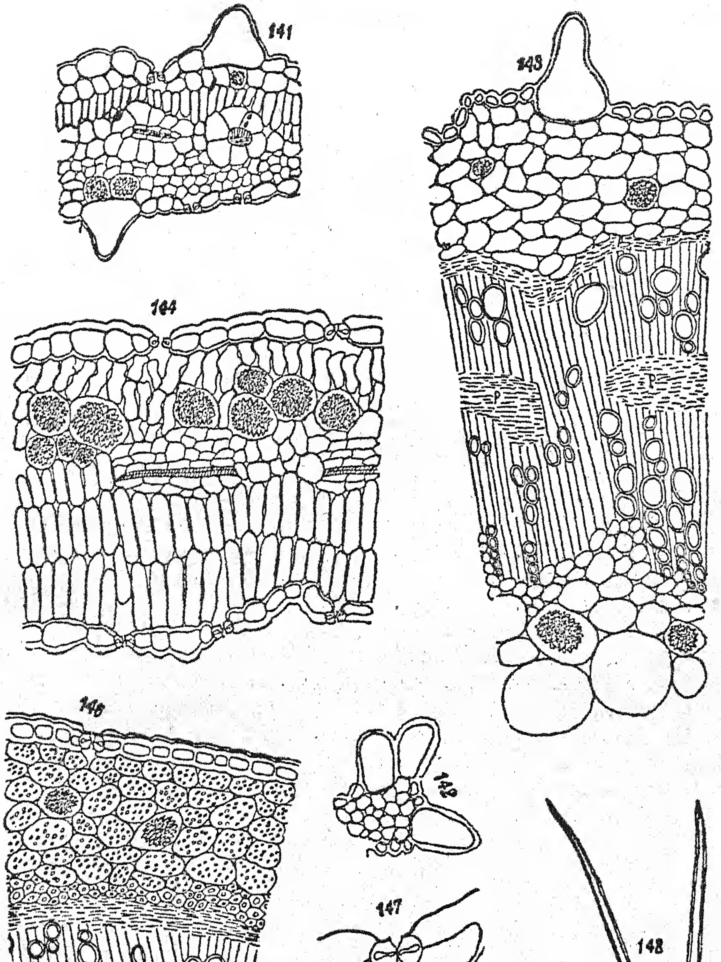
Plate XVI

141-143. *Trianthema pentandra.*
141. T. S. of the leaf.
Oc. 2 Com.; Ob. 3 mm. Ap.
142. T. S. of the leaf showing the enlarged epidermal cells.
Oc. 6 Com.; Ob. 8 mm. Ap.
143. T. S. of the axis.
Oc. 6 Com.; Ob. 8 mm. Ap.

144-147. *Orygia decumbens.*
144. T. S, of the leaf.
Oc. 6 Com.; Ob. 8 mm. Ap.
145. Stoma on the axis.
Oc. 6 Com.; Ob. 3 mm. Ap.
146. T. S. of the axis.
Oc. 6 Com.; Ob. 8 mm. Ap.
147. Stoma on the leaf.
Oc. 6 Com.; Ob. 3 mm. Ap.

148. *Mollugo hirta.*
Hair on the axis.
Oc. 4 Com.; Ob. 8 mm. Ap.

N.B.—To get the original dimensions multiply by 1·7.



T. S. Sabnis del.

PLATE XVI.

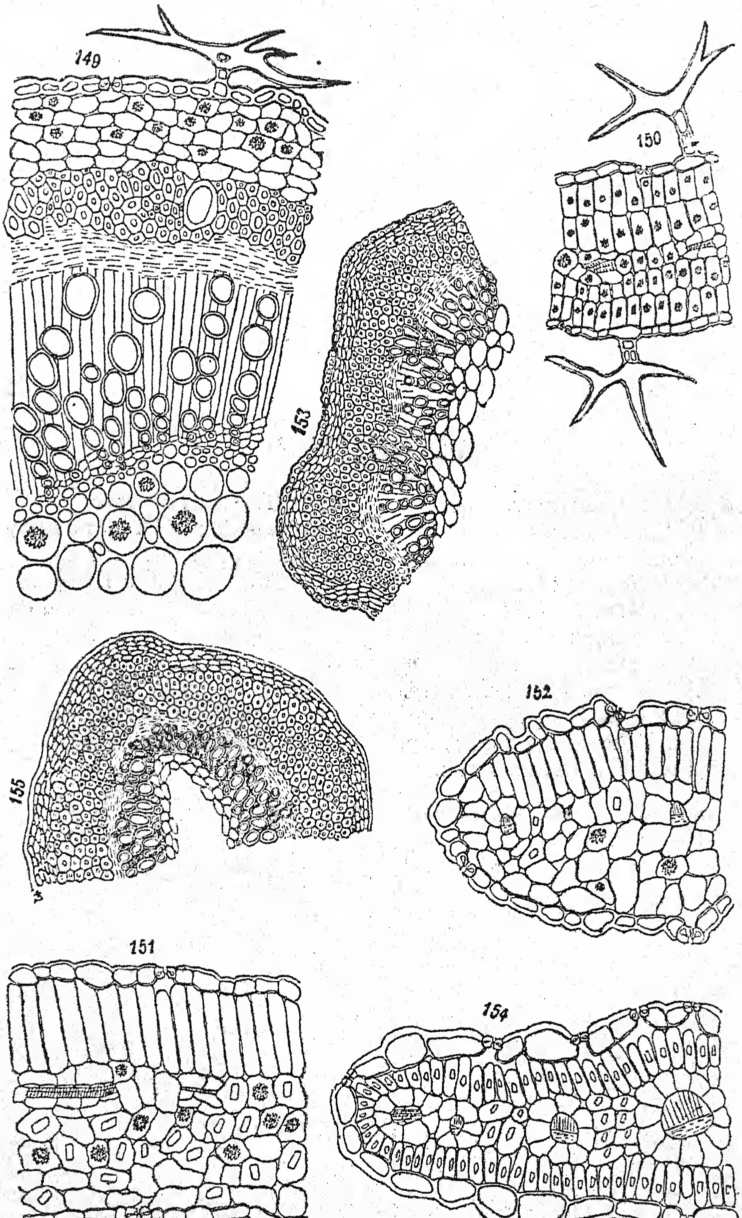
Plate XVII

149-150. *Mollugo hirta.*
149. T. S. of the axis.
Oc. 6 Com.; Ob. 8 mm. Ap.
150. T. S. of the leaf.
Oc. 2 Com.; Ob. 3 mm. Ap.

151-153. *Mollugo nudicaulis.*
151. T. S. of the leaf between the mid-rib and the margin.
Oc. 4 Com.; Ob. 3 mm. Ap.
152. T. S. of the leaf near the margin.
Oc. 4 Com.; Ob. 3 mm. Ap.
153. T. S. of the axis.
Oc. 4 Com.; Ob. 8 mm. Ap.

154-155. *Mollugo Cerviana.*
154. T. S. of the leaf representing half the leaf-blade including the midrib.
Oc. 6 Com.; Ob. 8 mm. Ap.
155. T. S. of the axis representing half the axis.
Oc. 2 Com.; Ob. 3 mm. Ap.

N.B.—To get the original dimensions multiply by 1·7.



T. S. Sabnis del. PLATE XVII.

Plate XVIII.

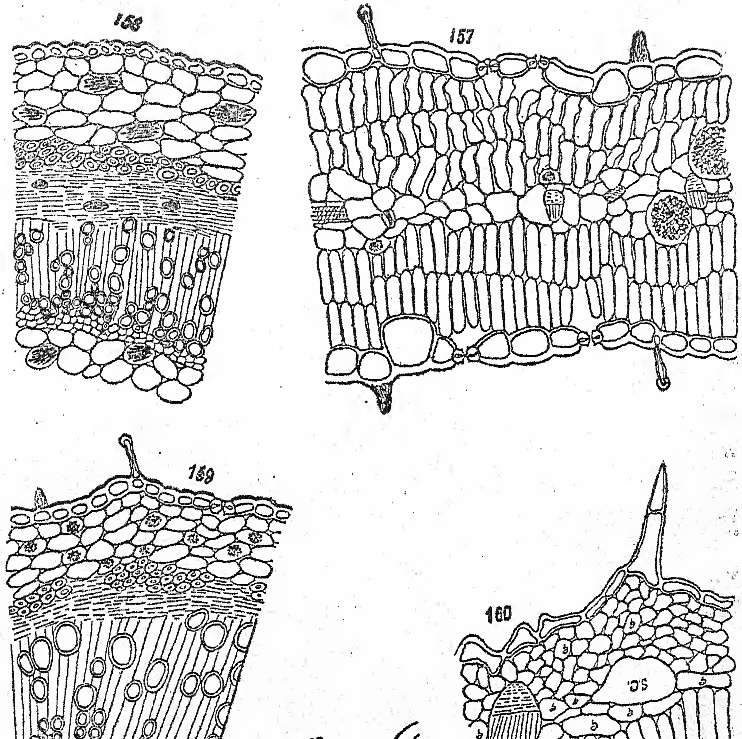
156. *Gisekia pharnaceoides.*
T. S. of the axis.
Oc. 4 Com.; Ob. 8 mm. Ap.

157-159. *Limeum indicum.*
157. T. S. of the leaf.
Oc. 6 Com.; Ob. 8 mm. Ap.
158. Stoma on the leaf.
Oc. 4 Com.; Ob. 3 mm. Ap.
159. T. S. of the axis.
Oc. 4 Com.; Ob. 8 mm. Ap.

160-161, *Spermacoce hispida.*
160. T. S. of the leaf.
Oc. 4 Com.; Ob. 3 mm. Ap.
161. T. S. of the axis showing the wing-like rib bearing hairs.
Oc. 6 Com.; Ob. 8 mm. Ap.

162. *Oldenlandia aspera.*
T. S. of the axis showing the dome-like hairy outgrowth
Oc. 4 Com. Ob.; 3 mm. Ap.

N.B.—To get the original dimensions multiply by 1·7.



T. S. Sabnis del. PLATE XVIII

A CONTRIBUTION TO THE ECOLOGY OF THE UPPER GANGETIC PLAIN

BY WINFIELD DUDGEON,

Ewing Christian College, Allahabad.

Introduction.

There is little published information about the ecological relations of the vegetation of the Upper Gangetic Plain. In their monumental survey and summary of the vegetation of India, HOOKER AND THOMSON (4) have little to say of this area. They state that there are no forests except at the base of the Himalayas, and that uncultivated tracts are usually covered with loose "bush-jungle". As every writer must do, they call attention to the markedly periodic climate. SCHIMPER (10) concludes that a rainfall below 90 cm. per annum produce "xerophilous scrub", while above that amount produces "xerophilous woodland". Allahabad has a mean annual rainfall of very nearly 90 cm., but the connection of the vegetation with some type of a Schimper climatic climax is not so obvious.

The Upper Gangetic Plain, comprising roughly the United Provinces, is a very distinct ecological area. Eastward it passes into the much more humid climate of Bengal; southward it merges into the hilly regions of the Vindhias, where the climate is similar but the vegetation is distinct; westward it passes into the drier Panjab; and northward it is abruptly limited by the Himalayas. The rainfall diminishes westward, and increases northward and rapidly eastward. The climate is continental, with great range between winter and summer and between day and night.

This study is restricted to a small area about ten miles in radius with Allahabad at the center. Such a restriction is chosen because I am more familiar with this limited area, and because it is quite representative of the much larger area of the Upper Gangetic Plain.

Physical features of the area.

Allahabad is situated at 25° 26′ N. Latitude and 81° 52′ E. Longitude, at the southern edge of the great plain of the Ganges and Jamna Rivers, at their junction. The Meteorological Observatory is 319 feet above mean sea level, and this may be taken as approximately the level of the surrounding plains. The soil (9) is all alluvial, deposited within recent geological times. It ranges from sand, through a mixture of sand and clay, to fine clay. The older alluvium often contains deposits of calcium carbonate in irregular nodules, locally called

"kankar". Both rivers have been depressed in the recent past, so that even the highest floods no longer inundate the surrounding plains. In the immediate flood-plains of the rivers there are limited patches of quite modern alluvial deposits, which are subject to redistribution when the streams are in flood. Near the rivers, and especially the Jamna, there are often deep ravines with precipitous sides, formed as the result of rapid erosion during the short monsoon season. During the rest of the year they are stable.

Except where dissected by these ravines, the surrounding plains are monotonously level. Here and there are slight natural depressions which become shallow lakes during the rainy season, but which are dried up later by evaporation, and by use of the water for irrigation purposes. There are very numerous artificial pools, made for collecting a supply of water to be used for irrigation during the winter and spring. Some of them are deep enough and extensive enough that they retain some water throughout the year. Lastly, there are a very few deeper and more permanent bodies of water created by damming up ravines. Some of the larger natural depressions catch the drainage sufficiently large area to accumulate considerable amounts of salts, chiefly sodium sulphate, mixed with more or less sodium chloride and sodium carbonate, and hence become "alkali", known locally as "usar". Aside from variations in the amount of water present, and from the deposits of usar, the soil of the plains presents a very uniform substratum for the growth of vegetation.

The factors influencing and determining the vegetation.

Climatic factors usually are considered to be the most important factors in the ecology of an area, but in the Upper Gangetic Plain biotic factors are at least of equal importance. The climatic differ only in degree from those met with in other parts of the world. The climate is characterized by striking periodicity. No interpretation of the vegetation can be complete without due consideration of the biotic factors, of which the most important are the very dense agricultural population, and other factors associated with a crowded population.

1. The climatic factors.

The climatic factors that appear to be of greatest importance are rainfall, insolation, temperature, humidity, and air movements. These factors are so distributed as to result in a strongly periodic climate. The data I have made use of are mostly taken from the records of hourly obser[illegible] Allahabad Meteorological Obser[illegible] 8ent
extending o[illegible] le number of years. [illegible] bout mean [illegible] laces
[illegible] lea[illegible] f April,

Rainfall. The mean annual rainfall for Allahabad, calculated in 1913 (7), is 37·54 inches; other calculations put it as high as 40 inches. The distribution of this fall is indicated in Table I and Fig.

Table I

—		Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Rainfall	...	0.83	0.45	0.23	0.16	0.07	4.14	11.25	10.54	5.10	2.52	0.31	0.14
Per cent.	...	2.3	1.3	0.6	0.4	0.2	11.6	31.5	29.5	14.3	7.1	0.9	0.4

Mean monthly rainfall in inches, and percentage for each month, for Allahabad.

From this table it will be seen that 94 per cent. of the rainfall occurs during the months of June to October, while only about 1 per cent. falls during March, April, and May. The rainfall is remarkably uniform from year to year (8). In 44 years a deviation of 33 per cent. or more above normal has been observed but seven times, and a corresponding diviation below normal but six times. The greatest recorded rainfall was 76·25 inches in 1894, and the lowest 16·82 inches in 1864.

During the monsoon the rains are at times torrential, at other times gentle and lasting for one or more days. The soil is baked hard by the intense heat and drought of spring, and wherever drainage has been established the more violent rains quickly run off. Under such conditions erosion is heavy, and the soil is wet only to a slight depth. After unusually heavy rains the level areas become vast shallow seas; one may travel for miles along the railways and see no land except the railway embankment and the mounds on which villages are situated. Water is retained in the shallow depressions, from which it disappears at length by evaporation and by use for irrigation. In consequence, where there is good drainage there is little accumulation of water in the soil, but where drainage is poor, the soil, or at least the surface soil exploited by plants, is saturated.

Insolation. Little has been done with this climatic factor. The Meteorological Observatory has kept hourly observations of cloudiness, using the usual scale of 0—10, where 0 indicates a cloudless sky, and 10 indicates the sky completely overcast by dense clouds or low fogs. Such a record is necessarily a matter of judgment, and ture of same value in the study of climat..er alluvium .. have nothing deposits of calc..t proportion of the so..lar nodules, l..he form of

heat, what in the form of visible light, and what ultra-violet. Table II shows the observed records of mean cloudiness, based on hourly observations extending over a number of years; these same records are plotted in graphical form in Fig. 3.

Table II

—	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
—	1·6	1.8	1.9	1.6	1.7	5.0	7.4	6.7	4.1	2.0	0.7	0·8

Mean monthly cloudiness on the scale of 0—10, for Allahabad.

Clouds become common in June, perhaps two weeks before the rains actually begin. June to September are the cloudy months. In June there are densely cloudy days interspersed with days of burning sunshine. During July and August the clouds are denser and more persistent, but even then there are breaks when the sun shines from a nearly cloudless sky with the intensity of the dry season. From September on the number of sunny days gradually increases, till in November the sky is cloudless or overspread with only thin hazy clouds for weeks at a time. This is broken at some period during December, January or early February by the "winter rains", when for a short time monsoon rains are repeated on a miniature scale. During most of the time from the end of the rains to the beginning of the next monsoon the sun shines down with unbroken violence, accentuated during March, April, and May by low humidity.

Temperature. The climate of the Upper Gangetic Plain is distinctly continental. The nearest large body of water is the Bay of Bengal, more than 400 miles to the eastward. The temperature accordingly exhibits a large range between winter and summer, and between day and night, despite the fact that Allahabad is barely outside the tropics. The lowest temperature occurs in December, when the mean is 59.0° F.; January is 0.3° warmer. From then on there is rapid rise to a maximum of 91.6° F. in May and June. The high point that should be reached in June and July is prevented by the increasing cloudiness of June, and the following monsoon. In July the mean temperature is 84.4°, falling to 83.0° in September. Her[e] what would be the normal descending curve is met again, and th[e] is rapid to the 59.0° of December. Table III shows the temp[...] in degrees Fahrenheit by months for the year (see Figs[...]

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Table III

—	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean maximum ...	73.4	79.8	92.9	102.6	104.4	99.6	89.2	89.3	90.3	88.0	81.2	74.2
Mean ...	59.3	64.9	77.8	87.6	91.6	91.6	84.4	84.1	83.0	76.2	66.3	59.0
Mean minimum ...	49.2	52.5	64.1	73·4	79.6	85.1	80.4	80.0	77.4	67.6	56.1	48.6
Mean daily range.	24.2	27·3	28.8	29.2	24.8	14.5	8·8	9.3	12.9	20.4	25.1	25.6

Mean, mean maximum and mean minimum temperature, and mean daily range, in degrees Fahrenheit, by months, at Allahabad.

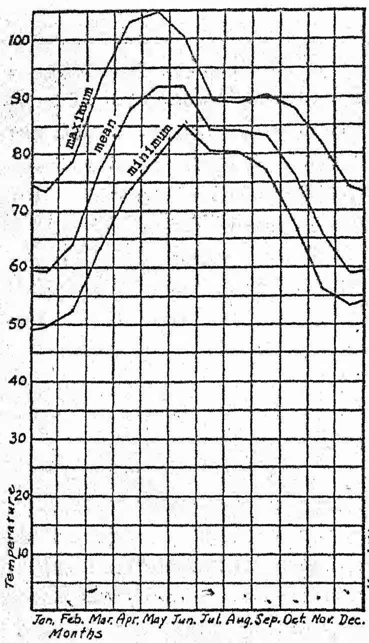

Fig. I

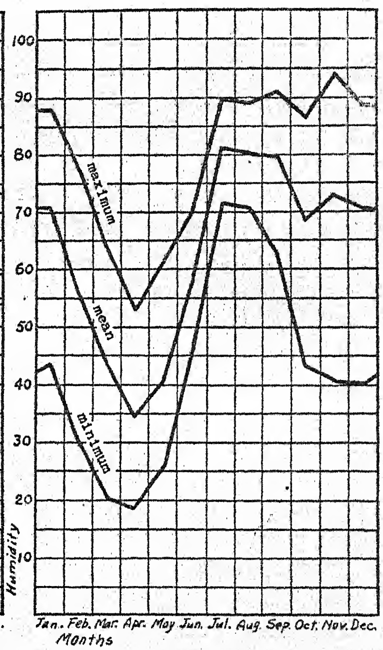

Fig. 2

Fig. 1. Mean, mean maximum and mean minimum temperature in degrees Fahrenheit for the year at Allahabad.

Fig. 2. Mean, mean maximum and mean minimum relative humidity in per cent. for the year at Allahabad.

The daily range of temperature is large throughout most of the ness, (Table III). During the monsoon it reaches a minimum of sky, at in July, then rises through the autumn and winter to a or low fogs 29.2° in April; from here it falls again rapidly to July. ture of sand val ximum daily temperature range coincides roughly deposits of calc highest absolute temperature.

Such temperatures as the above means alone would not be unfavorable for plants; it is the occasional extremes that make plant growth difficult. The mean annual extremes range from 39.6° to 114.9° F. On rare occasions the temperature of a winter night may drop down to or below the freezing point, but apparently these exceptional low temperatures are of little importance in determining either the character or the composition of the vegetation, even in depressions where frost is most liable to occur. The highest recorded temperature was 119. 8°F., on June 19, 1878 (8). It is the occasional unusually high temperature during the hot season, together with low humidity and a strong wind, that makes plant life difficult.

The temperatures given above were taken under open thatched sheds, at a height of 4 feet from the ground. The temperature at the soil surface at times rises very much higher than these figures (6) "The average temperature of the ground surface in India is, at the hottest time of the day in the cold weather from 10° to 20° (F.) above that of the air at 4 feet high. The difference increases until the months of April and May, when the excess is usually as high as 40° and sometimes 45° or 50° (F.)". It falls rapidly during the rainy season, and is as small in August as in the cold season.

Humidity. Temperature and humidity seem to be the most important of the climatic factors influencing plant development. Perhaps humidity is the most important, for if the proper balance between water loss and water intake could be maintained, plants would be able to endure without much difficulty the maximum temperatures of the Gangetic Plain. In general, humidity depends on rainfall, but during the cold season the low temperature is an important factor in increasing the relative humidity.

From a mean of 70.4 per cent. in January, the relative humidity falls rapidly to a minimum of 34.7 per cent. in April, then rises rapidily to a maximum of 81.9 per cent. in July. There is a slow fall to 80.2 per cent. in September, then it becomes rapid with the cessation of the rains, down to 68.9 per cent. in October. Here it is overtaken by the falling temperature, and rises to 72.9 per cent. in November, and 70.5 per cent. in December and January. With th rapidly rising temperature and low rainfall of the hot season it very rapidly to the April minimum. See Table IV and Figs. 2 The periods of high relative humidity are optimum for plant As in the case of high temperature, it is the periods of low that cause trouble. The daily humidity range is great du of the year. Maximum humidity usually occurs at abou and minimum at about 14 o'clock. July shows the lea

and November the greatest, though the range is great throughout the cold season. The daily range during the hot season is intermediate.

Table IV

—	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean maximum ...	88.2	76.5	63.7	53.2	61.5	70.4	89.6	89.3	91.3	86.4	94.1	88.6
Mean ...	70.4	55.6	43.2	34.7	41.4	58.6	81.9	80.5	80.2	68.9	72.9	70.5
Mean minimum ...	43.5	30.9	21.0	18.4	25.2	45.4	71.7	70.1	62.9	43.4	40.7	40.5
Mean daily range ...	44.7	45.6	42.7	34.8	36.3	25.0	17.9	19.2	28.4	43.0	53.4	48.1

Mean, mean maximum and mean minimum relative humidity, and mean daily range, in per cent, by months, for Allahabad.

The mean relative humidity by months gives a very inadequate picture of the severe conditions to which plants are subjected in the hot season. During April, for example, the mean is 34.7 per cent. but the mean minimum attained about 14 o'clock, is 18.4 per cent. and there are many days when the extreme runs much below this; even at night the mean maximum is only 53.2 per cent. During the rainy season humidity is generally high, and at all times very favorable for plants. During the cold season the mean maximum attains the highest point for the year, reaching 94.1 per cent. in November. Night after night there is a havy fall of dew. At the same time the daily range is greatest during this period, the 14 o'clock mean minimum dropping to 40 per cent. The humid nights permit the vegetation to recover from the drought of daytime. During the hot season, however, there is little opportunity for recovery following the extremely dry day, and none but the most xerophytic of the herbaceous plants are able to survive this trying period.

Wind. The wind is an important climatic factor in two distinct ways: by bringing in moisture during the rainy season; and by accentuating the aridity of the hot season. In the latter case only air currents near the earth are of importance. During most of the year the winds blow fitfully, with a large percentage of the time calm. During March, April and May, wind becomes a very important factor influencing vegetation. Beginning about 11 and continuing till 16 or 17 o'clock, there is a strong wind from the N.N.W., known as the "lu." Coming as it does at a time when relative humidity is at the lowest point, it exerts a powerful effect on vegetation. The soil is dried out by wind and [illegible]r, and little herbaceous vegetation that is not protected, [illegible] situated with regard to water supply, is able to survive. [illegible] no air movement at night during the hot season.

Climatic seasons. From the foregoing it will be seen that the climate is markedly periodic, and divides quite naturally into three

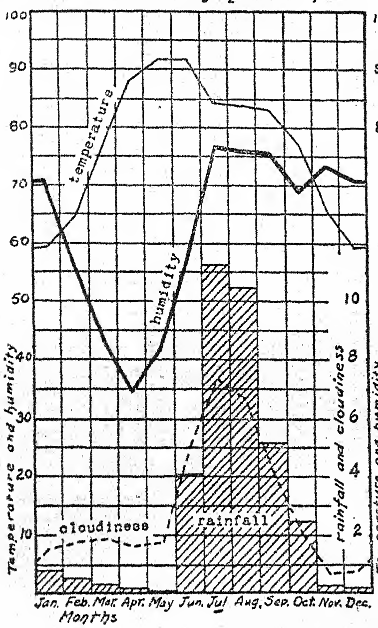

Fig. 3

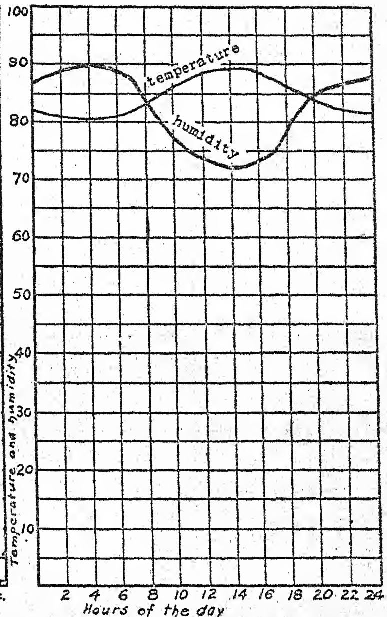

Fig. 4

Fig. 3. Mean temperature in degrees Fahrenheit, mean cloudiness on the scale of 0—10, mean rainfall in inches, and mean relative humidity in per cent. for the year at Allahabad.

Fig. 4. Mean hourly temperature in degrees Fahrenheit and mean relative humidity in per cent. for the month of July at Allahabad.

seasons: a Rainy Season; a Cold Season; and a Hot Season, (Fig. 3). Corresponding with the climatic seasons there are three distinct

Table V

Hours of the day	2	4	6	8	10	12	14	16	18	20	22	24
APRIL												
Temperature ...	76 9	74.6	73.4	84.2	94.9	100.1	102	101 6	95.0	86.4	82.4	79.6
Humidity ...	46.5	50.6	53.2	38.9	26.6	21 2	18.4	18.7	25.5	34.8	40.1	43 0
JULY												
Temperature ...	81.5	80.6	80.6	83.1	86.2	88.1	89.2	88.4	86.5	[illegible]	82.7	82.2
Humidity ...	88.1	89.3	88.8	83.8	77.6	73.9	71.7	73.0	77.4	84.7	86.2	87.3
DECEMBER												
Temperature ...	51.0	49.7	48.6	52.6	63.5	71.6	74.2	71.8	61.2	57.4	54[illegible]	[illegible]
Humidity ...	85.5	86.7	88.4	80.8	57.6	45.1	40.5	46.4	70.9	76.8	81[illegible]	[illegible]

Hourly mean temperature in degrees Fahrenheit and mean humidity in per cent., on the even hours, for the months of April, December, at Allahabad.

vegetational seasons. From the point of view of the vegetation it is convenient to begin the year with the rainy season (Fig. 7). This season may be taken to begin about the 15th to the 20th of June, when the first scattering rains fall, and lasts to the end of September. It is characterized by high rainfall, low insolation, high temperature, and high humidity (Table V, and Figs. 4 and 7). July may be taken as typical of this season, when the mean temperature range is from 80.6° to 89.2°F., while the relative humidity ranges from 89.3 to 71. 7 per cent. Such conditions are optimum for plant growth, and a luxurient herbaceous vegetation springs up.

The rainy season merges gradually into the cold season, which may be taken to extend from the first of October to the end of February. It is characterized by low rainfall, high insolation, low temperature, and relatively high humidity. December may be chosen as a typical month; the mean temperature range is from 48.6° to 74.2°F., and the relative humidity runs from 88.4 to 40.5 per cent. (Table V, and Figs. 5 and 7). The lower temperature and the low

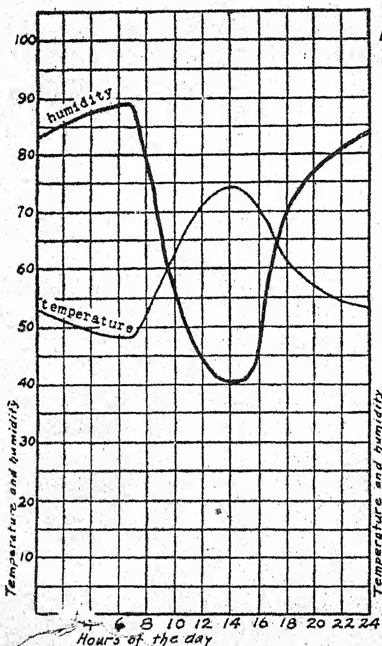

Fig. 5

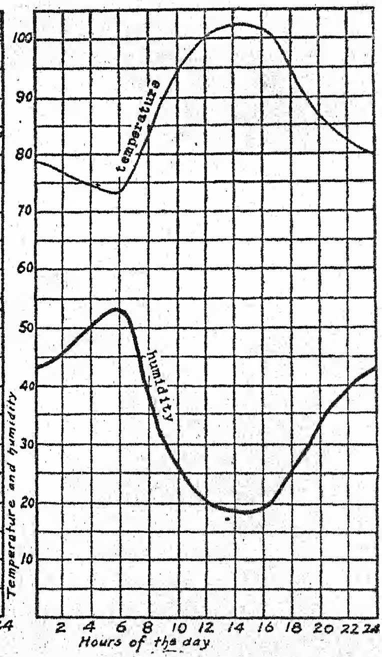

Fig. 6

Fig. 5. Mean hourly temperature in degrees Fahrenheit and mean relative humidity in per cent. for the month of December at Allahabad.

Fig. 6. The same for the month of April.

ity of midday result in a vegetation that is mesophytic, and ontains a larger proportion of temperate region plants.

The hot season is ushered in with the rising temperature and decreasing humidity of spring, and extends from the first of March to the middle of June. It is characterized by low rainfall, high insolation, high temperature, low humidity, and strong winds. April and May are typical of this season. The April temperature ranges from 73.4° to 102.6° F., and the humidity from 53.2 to 18.4 per cent. (Table V, and Figs. 6 and 7). Both temperature and humidity are

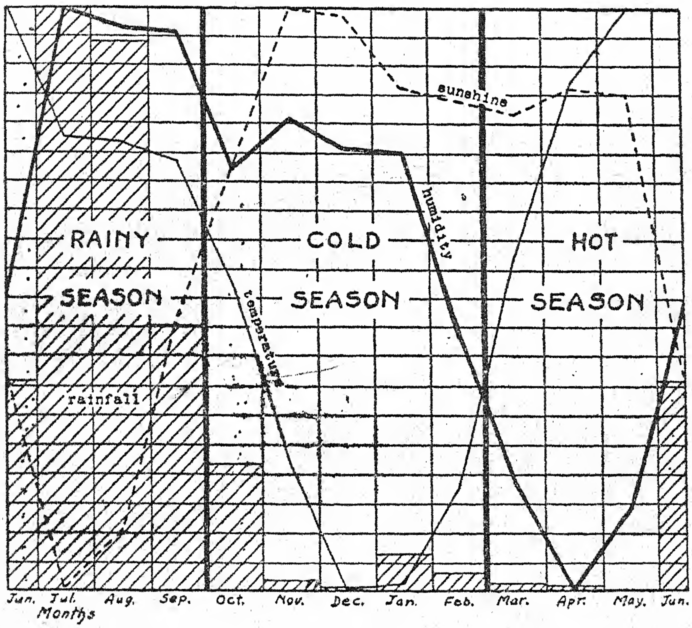

Fig. 7

Fig. 7. Mean temperature, mean sunshine (mean cloudiness curve inverted), mean rainfall, and mean relative humidity for the year at Allahabad, so calculated that all the maxima touch the top of the graph and the minima touch the bottom. This emphasizes the three climatic seasons, which determine three corresponding vegetational seasons.

slightly higher in May. The climatic conditions are distinctly xerophytic, with the result that the mesophytic vegetation of the cold season disappears, and only those plants that are adapted to withstand the severe drought can survive. There are limited local areas that for some reason or other are able to supply sufficient moisture to sustain mesophytic plants, and it is in such places only that the vegetation remains distinctly green.

2. The biotic factors.

The term "biotic factors" includes all influences traceable to living organisms, but only animals and man are considered in this paper. Undoubtedly man and his domesticated animals are the most important of the biotic factors. For more than 20 centuries the Gangetic Plain has been populated with an agricultural people. It is difficult and perhaps impossible to form any adequate conception of the intensity of the human factor in times past, but since 1850 the population of the 2811 square miles of Allahabad District has fluctuated from 480 to the high level of 543 to the square mile at the 1891 census (8). At present it is about 530 per square mile. To the human population must be added, according to census of 1909, 331 cattle and buffaloes, 123 sheep and goats, and 8 horses and donkeys, or a total population of domestic grazing animals of about 463 per square mile. Therefore the area has to support a total population of about 1,000 per square mile of animals that gain most or all of their food directly from the vegetation.

Man influences the vegetation in a number of ways, mainly by cultivation, by grazing his animals, and by cutting for food and fuel.

Cultivation. The returns of 1907-08 (8) show that about 58 per cent. of the District was under cultivation. This figure probable fairly indicates the extent of cultivated land from year to year in the area immediately surrounding the city of Allahabad. Cultivation causes retrogression of the vegetation, and the more thorough it is, the greater the effect. Wild plants, both annuals and perennials, are rooted up and killed, and their place is taken by annual ruderals, usually native, but in many cases introduced. At the same time cultivation tends to make the area more xerophytic by removing the permanent plant covering, and substituting a cover of perhaps more mesophytic but short-lived annuals. When the crop cover is harvested the soil is left practically bare, and dries out speedily.

Grazing animals. All of the uncultivated land in the area is closely grazed throughout the year. During the rainy season, the vegetation is able to keep pace with grazing, even though it is constantly kept eaten off close to the ground. As the cold season progresses and the growth of herbaceous vegetation is checked, the effect of overgrazing become more and more evident. Finally, during the dry season all grasses and associated plants are eaten down to the soil surface (Fig. 11). Annuals die under the combined hardships of the grazing and lack of protection. Only perennial grasses and a few other xerophytic herbs with strong perennating organs are able to survive. Where overgrazing progresses still further, even the peren-

nial grasses are destroyed, and the ground left practically bare (Fig. 14).

In consequence of the severe grazing there is no cover of vegetation on the ground to aid in conservation of the monsoon rains. Where drainage has been established, runoff of the monsoon rainfall is very rapid and complete; where the land is flat, the vegetation has no effect in preventing runoff.

The scattering thorny shrubs and small trees, with a few inedible exceptions, are kept eaten done to small dense rounded bushes wherever and as long as animals are able to reach them.

Cutting for food and fuel. In India a very large proportion of the plants comprising the flora is made use of by man for some specific purpose, especially for food and medicines. Perhaps the results of all such exploitation are not in the longrun very detrimental. Usually it is parts that are not essential to the life of the plant that are used for food. It is for forage and fuel that man works the greatest havoc with the vegetation. Throughout the year, and especially during the hot season, much of the available grass covering is cut off just below the surface of the soil for fodder for domestic animals. It is only the most persistent perennials that can survive such treatment. In the Upper Gangetic Plain no natural fuel remains except a few species of xerophytic shrubs and small tress, and in most places these are periodically cut, sometimes almost to the extinction point. The fine groves about villages are all planted, and these alone escape the unremitting struggle of man to find fuel. There is no attempt locally at conservation of plant resources.

Wild fires are negligible as a factor influencing vegetation, for the reason that the land is so intensively cultivated and grazed that there is nothing left to burn.

Wild grazing animals are not numerous and are of little importance. Earthworms are abundant during the rains, and their burrows probably are of considerable importance in promoting aeration and water penetration. Numerous species of black ants probably render a similar service. In general, insect pests are relatively unimportant. It is uncommon to find the indigenous vegetation eaten to any great extent.

White ants. White ants are the only insects that exert any great influence on the vegetation. They are found everywhere and are almost unbelievably abundant. Doubtless their burrows function as do those of the black ants, and they reach a depth of 5 feet or more. It is only rarely that white ants attack living plants, though they closely follow dying parts and keep them eaten away. When grasses and other plants, especially the annual vegetation, die, the

white ants eat the remains. The great problem in this connection is whether and to what extent they prevent the accumulation of this dead vegetation as organic matter in the soil. It may be that the intense heat and dryness of the hot season would oxidize organic matter even if it were introduced into the soil, though the experience from trenching indicates that this is not necessarily the case. It is probable that the organic matter eaten by white ants is oxidized within their bodies. This prevents the usual course of oxidation by the action of bacteria in the soil with the resulting increase of nitrates and solution of mineral constituents, and the soil is deprived of just so much fertility. In so far as they prevent the accumulation of organic matter in the soil, and thus impair its fertility and water-holding capacity, white ants are detrimental to the vegetation.

Almost literally every square inch of ground is either cultivated or grazed. Excessive grazing is by far the most important of the local biotic factors. It becomes increasingly evident that there can be no adequate interpretation of the vegetation of such an area as the Upper Gangetic Plain without due consideration of the tremendous pressure of the human factors. Neither climatic nor biotic factors alone, but all acting together, influence and determine the vegetation.

Ecological features of the vegetation.

Types of succession. It is well established that under natural conditions the vegetation of new local areas, such as ponds, stream margins, cliffs, bare rocks, cultivated tracts, and the like, passes through a succession of associations, finally culminating in a permanent climatic climax. COWLES (3) distinguishes two types of succession in any given region :—(1) Climatic, depending on slow changes in geologic climate, and which is at all times in the stage of climatic climax; and (2) Topographic, occurring as smaller cycles of development within the immensely large climatic succession, and dependent on local physiographic variations. The climatic succession progresses so slowly that it cannot be made the subject of exact study. Topographic succession progresses much more rapidly, but still is a slow process. It usually is assumed that the associations observed in passing from a new area to the climax fairly represents the succession as it occurs at any given spot through a long period of years. Each topographic succession area has as its goal the climatic climax vegetation, and is terminated when this stage is attained.

Seasonal succession. A third type of succession is a prominent feature in a strongly periodic climate. It is illustrated by the

could develop naturally. Such a flora now represents the climatic climax as degraded and modified by man. It is the resultant of the struggle between the vegetation on the one hand developing toward some type of climatic climax forest, and the retrogressive influence of the intense human factors on the other hand, continually interfering with and destroying it. This balance between man and the natural vegetation is very delicate, and may perhaps help to explain many of the very serious human problems of the area. After a series of favourable years, the slightly increased vegetation allows a corresponding increase in the human and animal population, and results in increased demands on the plant resources. Then subsequent bad years leave the men and animals with insufficient food, and if many do not die as the direct result of famine, they are left so weakened as to become easy prey to pestilence, and are again reduced in numbers. In other words, under present conditions, the human and animal population is about as large as the area can support. Improved methods of agriculture, and intelligent protection and conservation of the plant resources appear to be the only solution of the problem.

Pioneer monsoon deciduous forest stage. If left to itself, it is very probable that the thorn scrub would in turn be replaced by some form of higher and more mesophytic forest. SCHIMPER concludes (10) that if the annual rainfall is below 90 cm., "xerophilous scrub", especially "thorn forest" and "thorn bush," prevails; with 90—150 cm. there is a struggle between "xerophilous woodland" and grassland, with the former prevailing when there are greater heat and longer rainless periods during the vegetative season. With 180 cm. or more rainfall, a high forest is produced. BRANDIS (1) says that "really thriving forests are only found where the fall exceeds 40 inches, and a rich luxurient vegetation is limited to those belts which have a much higher rainfall."

The highest type of vegetation about Allahabad, the scrubby xerophytic shrubs and trees, would, I think, correspond roughly to Schimper's "thorn scrub." Doubtless in most regions treated by Schimper, the vegetation described as climax actually is climatic climax. He was recording situations as they actually are; some of them at least are not necessarily climatic climaxes but modified claimaxes due to retrogressive influences. To class the thorn scrub of the Upper Gangetic Plain as the true climatic climax is a mistake. On Schimper's classification, the rainfall in the area about Allahabad should produce a forest somewhere between "xerophilous scrub" and "xerophilous woodland". It is difficult to determine exactly what these terms mean. Probably each writer must provisionally fix his own limits to them. Certainly

the Allahabad thorn scrub is not truly xerophilous. According to Brandis the area ought to be able to support a "really successful forest". In adjacent hilly regions, especially to the south, where there is a much smaller amount of land suitable for cultivation, and the population consequently is much less, a successful forest occurs (Fig. 16). It appears as if forests and density of population may be definitely correlated with each other in India.

We must assume then that if the human factors were lessened or eliminated, the area would more or less rapidly pass into the complete thorn scrub stage, or even into a true thorn forest. In the protection of the grasses, shrubs, and trees of this forest, a more mesophytic type of forest would develop. Some of the thorn scrub trees, as *Zizyphus jujuba*, *Acacia arabica*, and *Alangium lamarckii*, would develop to much larger dimensions (Fig. 15). *Butea frondosa* would become abundant. Such a forest is pioneer to the climatic climax in the mountainous region to the south. Other trees, as *Dalbergia sissoo* Roxb, and *Holoptelea integrifolia* Planch, at present exclusively cultivated would quite readily become self-perpetuating components of such a forest. Finally, there would be the slower influx of truly climax trees from neighboring forested areas.

The development of such a forest might result in some increase of rainfall, making conditions still more favorable for the development of a high forest. BRANDIS records (2) an instance of slight increase of rainfall following thorough-going protection of a large forest tract in Central India. Certainly a dense intermediate forest, with its accompanying herbaceous and shrubby floor vegetation, would greatly conserve rainfall by preventing rapid run-off of the monsoon rains, and by increasing the relative humidity during the hot season.

Climatic climax monsoon deciduous forest stage. Probably the dominant constituents of the ultimate climatic climax forest would be immigrants from neighboring forested areas to the north and south. We should expect to find *Terminalia tomentosa* Bedd, and *Tectona grandis* L., dominant. Almost certainly species of *Sterculia*, *Bombax malabaricum* DC., *Anogeissus latifolia* Wall, *Stephegyne parvifolia* Korth., *Buchanania latifolia* Roxb., *Eugenia jambolana* Lamk., and other fine trees, and *Dendrocalamus strictus* Nees would invade the area from the forests both to the north and to the south. *Acacia catechu* Willd., and even *Shorea robusta* Gaertn, might finally be represented. With such immigrants, and in the protection of their shade, a new herbaceous and shrubby vegetation, at present unknown in the area, would spring up. Perhaps several species now found only in favored places in protected planted groves would become components of this undergrowth.

Such a climax forest as has been sketched above is purely hypothetical for the area, but all natural conditions seem to warrant the assumption that it would develop. It would be a typical deciduous monsoon forest, decidedly tropophytic, leafless during some portion of the hot season. It would contain few bulbous herbs, few epiphytes, abundants lianas, and would have a great abundance and variety of grasses in the more open places. The fine forests at the north side of the Upper Gangetic Plain adjacent to the Himalayas, and in the more inaccessible parts of the Vindhias to the south (Fig. 16) may be taken as a picture of this hypothetical forest.

Summary

1. The area under discussion lies in a 10 mile radius about Allahabad, and is representative of a large part of the Upper Gangetic Plain.

2. The vegetation is influenced and determined as much by biotic as by climatic factors.

3. The climatic factors, rainfall, insolation, temperature, humidity, and air movements, are periodic in distribution, and produce three distinct seasons :

(a) Rainy season, from the middle of June to the end of September, with high rainfall, low insolation, high temperature, and high humidity.

(b) Cold season, from the first of October to the end of February, with low rainlall, high insolation, low temperature, and high humidity.

(c) Hot season, from the first of March to the middle of June, with low rainfall, high insolation, high temperature, low humidity, and large air movement.

4. The biotic factors are an agricultural population of about 530 per square mile, and associated domestic grazing animals of about 470 per square mile. Cultivation, grazing, and cutting for food and fuel have profoundly modified the original vegetation; constantly interfere with the normal development of the vegetation; and cause retrogression from the original climatic climax. White ants also probably exert marked influence on the vegetation.

5. The vegetation is characterized by:
   (*a*) Distinct seasonal succession, as the result of the pronounced climatic seasons.
   (*b*) A modified climatic climax degraded several stages from the true climatic climax for the area. The vegetation is now balanced against the intense human factors, at about the dry meadow or early thorn scrub stage.
   (*c*) Obscure topographic succession, due to interference by the human factors, which at times and in places are so severe as to entirely prevent succession.

6. Topographic succession presents the following stages:—
   (*a*) Aquatic stage.
   (*b*) Wet meadow stage.
   (*c*) Dry meadow stage, which occurs over most of the area, and is the modified climatic climax.
   (*d*) Thorn scrub stage, occurring in poorly developed form in many places.

7. It seems clear from the evidence that if the retrogressive influence of the biotic factors were removed, the vegetation would pass through progressively higher forest stages:—
   (*e*) Fully developed thorn scrub stage.
   (*f*) Pioneer monsoon deciduous forest stage.
   (*g*) Climatic climax monsoon deciduous forest, a forest of considerable density and luxurience.

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Explanation of Plates.

Plate XIX

Fig. 8. Permanent lake near Allahabad, formed by damming up a ravine. *Scirpus maritimus* is dominant in the attached emersed aquatic and wet meadow stages. Note the bare wet meadow shore left by the receding water. In the back-ground is a village grove of planted trees. Photographed January 30, 1920.

Fig. 9. Shallow temporary pool near Allahabad, showing the result of cultivation and grazing on early stages of succession. In the water and stranded on the wet meadow shore are the remains of a crop of *Oryza sativa*, along with *Panicum punctatum*, *Ipomaea reptans*, and *Cynodon dactylon*. Spontaneous *Acacia arabica* in the background. This view shows the flat character of the plains. November 4, 1917.

Fig. 10. Well developed wet meadow stage in the seepage area from the permanent lake in Fig. 8. In the shallow open water are submersed aquatics; in the edges of the pools is tall *Scirpus maritimus*; over the damp soil of the wet meadow stage are *Scirpus maritimus* and *Cyperus difformis*, fringed about by a dense mat of smaller *Fimbristylis diphylla*; outside this is a later stage of the wet meadow, dominated by *Cynodon dactylon*; dry meadow plants on the higher banks; and spontaneous *Acacia arabica* and planted village trees in the background. The whole area is closely grazed. January 30, 1920.

Plate XX

Fig. 11. Well drained area west of Allahabad, showing closely grazed dry meadow stage, with cultivated fields in level places. The meadow is dominated by *Andropogon intermedius* and a good representation of small perennial prostrate weeds. Spontaneous *Acacia arabica* in the background. April 20, 1918.

Fig. 12. Rank growth of thorn scrub grasses, *Apluda varia*, *Cenchrus biflorus*, *Andropogon contortus*, and *A. intermedius*, in the Fisher Forest, Etawah, as a result of five years protection from grazing. The trees are planted *Acacia arabica*. October 24, 1919.

Fig. 13. Closely grazed thorn scrub area north of Allahabad. The trees are *Acacia arabica*, the oval bushes are *Capparis sepiaria* pruned by grazing animals, and the straggling bushes are *Justicia adhatoda*. Over the ground is a poor development of the dry meadow. April 20, 1918.

PLATE XXI

Fig. 14. Overgrazed thorn scrub area north of Allahabad, showing untouched *Justicia adhatoda* and pruned *Capparis sepiaria*. The soil is bare and strewn with calcium carbonate nodules (kankar). The principal rainy season herbaceous vegetation is *Aristida adscenscionis*. April 13, 1919.

Fig. 15. Closely grazed thorn scrub stage near Allahabad. It is protected from cutting and the *Acacia arabica* and *Zizyphus jujuba* have developed into a fair forest. January 30, 1920. (This forest was cut off about March 1, 1920).

Fig. 16. Climatic climax monsoon deciduous forest at Ghansore, Central India. The trees are *Sterculia urens* Robx., *Dalbergia paniculata* Robx., *Anogeissus latifolia*, *Tectona grandis*, *Semecarpus anacardium* L., *Boswellia serrata* Robx., and *Hymenodictyon excelsum* Wall. The entire area is closely grazed. Such a forest as this would be expected to develop over much of the Upper Gangetic Plain following elimination of the intense human factors. January 18, 1920.

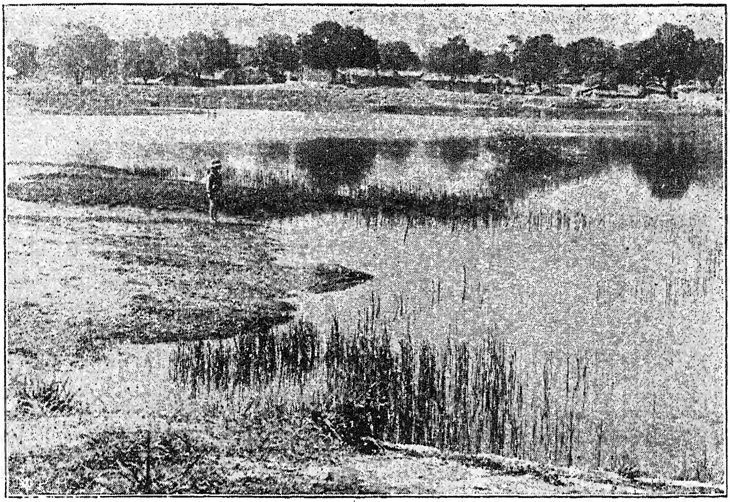


Fig. 8

Fig. 9

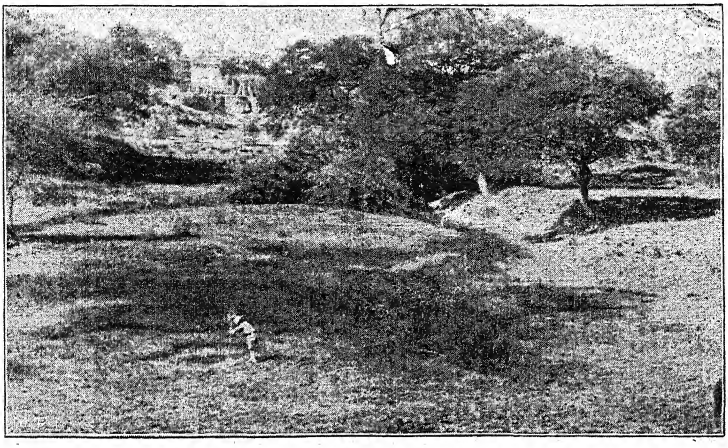


Fig. 10

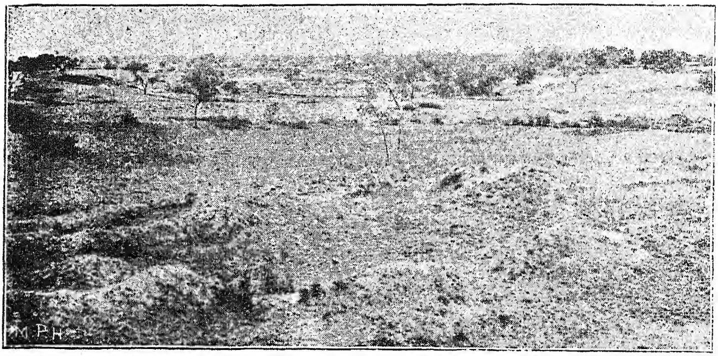


Fig. 11

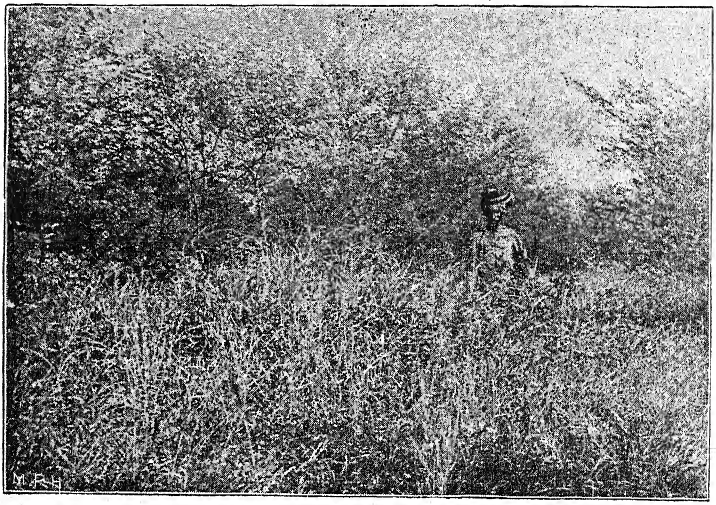


Fig. 12

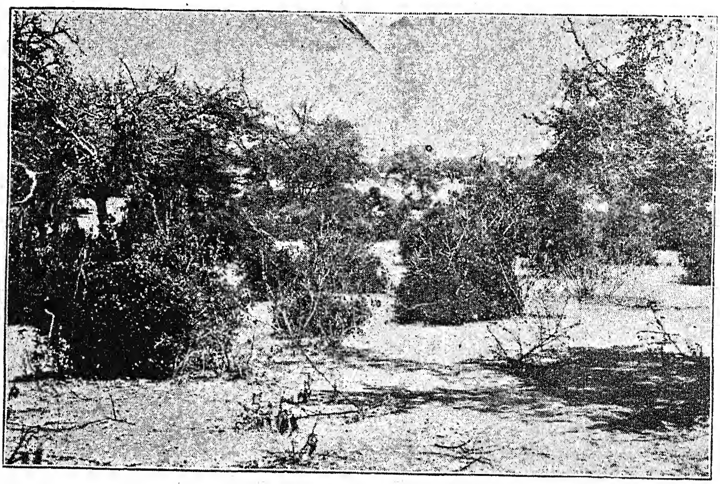


Fig. 13

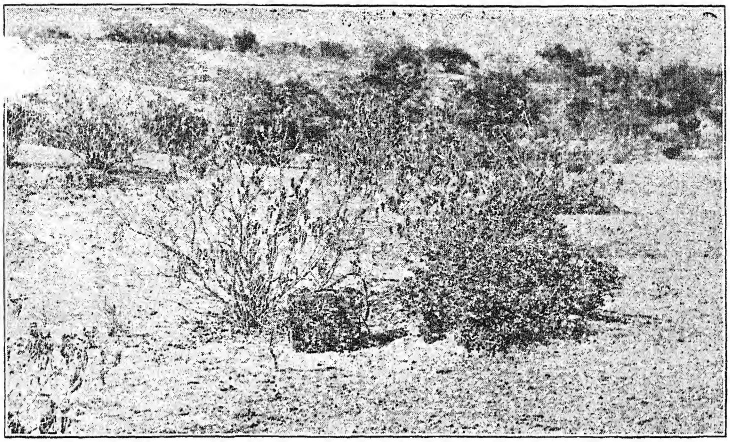


Fig. 14

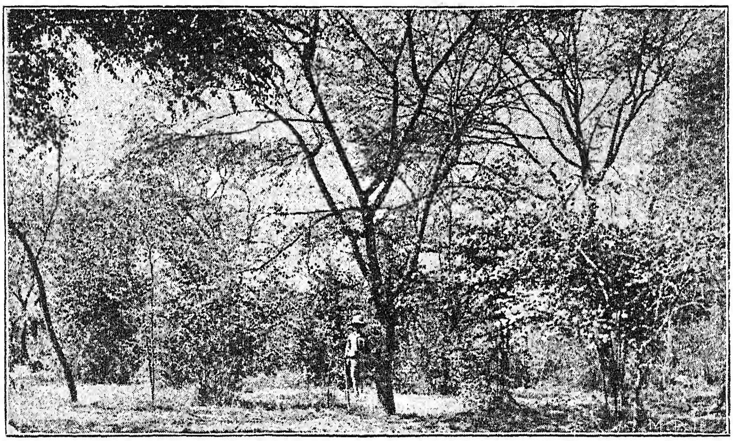


Fig. 15

Fig. 16

VARIEGATION IN CERTAIN CULTIVATED PLANTS

M. BALASUBRAMANYAM, B.A., (Hons.), *Sacred Heart College, Shembaganur.*

The interesting paper by Bateson on Variegation in certain plants, led me to examine at the instance of Professor Fyson some of the variegate species grown in Madras gardens, for the histological details of the differently coloured patches.

In *Pothos aurea*, Linden, the patches of green and yellowish-white parts are not sharply defined, partly because the loss of chlorophyll as one passes from a green to a light part is gradual, and partly because the green occurs in flecks in the light parts, and the light in flecks in the green, so that the leaf has a softly mottled appearance. On the under side the light parts are a little greener than the upper as if the chlorophyll persisted longer on the under side. The palisade on the lighter parts does not lose its characteristic structure but only its colour.

In some other plants the variegation takes the form of white patches, with very sharply defined edges because the chlorophyll is absent throughout the section. So that the patch is pure white from either side. This occurs for instance in a form of *Anthurium Sp.* where the white spots are characterised not only by the almost complete absence of chloroplasts, but also by the absence of all differentiation of tissue, the cells being nearly isodiametric. (Pl. II, Fig. 1.)

In *Maranta vittata* variegation takes the form of narrow white streaks between and parallel to the nerves which run acutely from the mid-rib, only on the upper side. But the palisade tissue loses not only its chlorophyll but also its characteristic form and consists of rounded cells indistinguishible from the spongey parenchyma, except for being colourless. The cells of the water-storage tissue of the upper side are here smaller, and the whole section somewhat thinner. (Pl. I, Fig. 1.)

In other species are indications of the existence of a middle tissue, between the upper (palisade) and lower (spongey) tissues of the mesophyll. Thus in a common garden *Dracaena,* round ill-defined spots of slightly lighter green, about 1/16 in. diameter occur here and there in the leaf. A transverse section shows the normal mesophyll to comprise a layer of obviously elongated cells (the palisade), a second layer of much shorter cells and five or six layers of loosely

arranged cells. In the lighter coloured spots a few layers in the middle of the spongey part are without chlorophyll (Pl. II, Fig. 2). The effect of the absence of colour in this deep seated portion is to produce lighter spots with hazy, ill-defined outlines.

A variegated form of *Alocasia macrorhiza*, Schott, said to have arisen as a sport, affords a most interesting variability in the distribution of the chlorophyll—deficient tissue. This is always quite definite (as regards each layer of the leaf) without any merging as in *Pothos aurea*, or haziness as in the *Dracaena*. Sometimes a plant will give several pure white leaves which, however, soon wither, and are succeeded by more normal ones, or else the plant of course eventually dies. Sometimes one whole half of a leaf is pure creamy white, without any trace of chlorophyll, while the other half is mottled. More usually the whole leaf is mottled as shown in Plate III. The mottling is in various degrees of lightness, and different on the two sides (compare the upper and under sides of the leaf in the plate).

Sections through different patches show that three regions can be recognised in the mesophyll, an upper (the palisade) a middle and a lower (the spongey-parenchyma). Writing the colours of these three regions in order from the top so that W.G.W. indicates white palisade, green core and white spongey-parenchma, We find the following combinations to occur :—

G. G. G.	G. G. W.
W. G. G.	G. W. W.
W. G. W.	W. W. W.
W. W. G.	

It will be seen that only one of the eight possible combinations is absent, viz., G.W.G., or white core and fully-green cortex.

Though the spongey-parenchyma is thicker than the core, the chlorophyll, is less dense, and in a leaf held up against the light, patches of W.G.W. appear to be nearly of the same tint as those of W.W.G. Again when viewed by reflected light only, patches of G.G.W. appear the same as those of G.W.W., because of the much greater intensity of the green in the palisade tissue than in the middle region, but by transmitted light they are distinguished at once except in the *Dracaena* referred to above, so far I have not found G.W.G., which would be *reverson*, in Bateson's sense of W.G.W.

A variegated *Eranthemum Sp.* shows the third middle layer even more clearly because the cells are coloured distinctly blue. This causes the leaf to have a dark bluey green colour except round the margin and in patches where the normal green or a lighter colour occurs. Where a vascular bundle traverses the mesophyll the blue

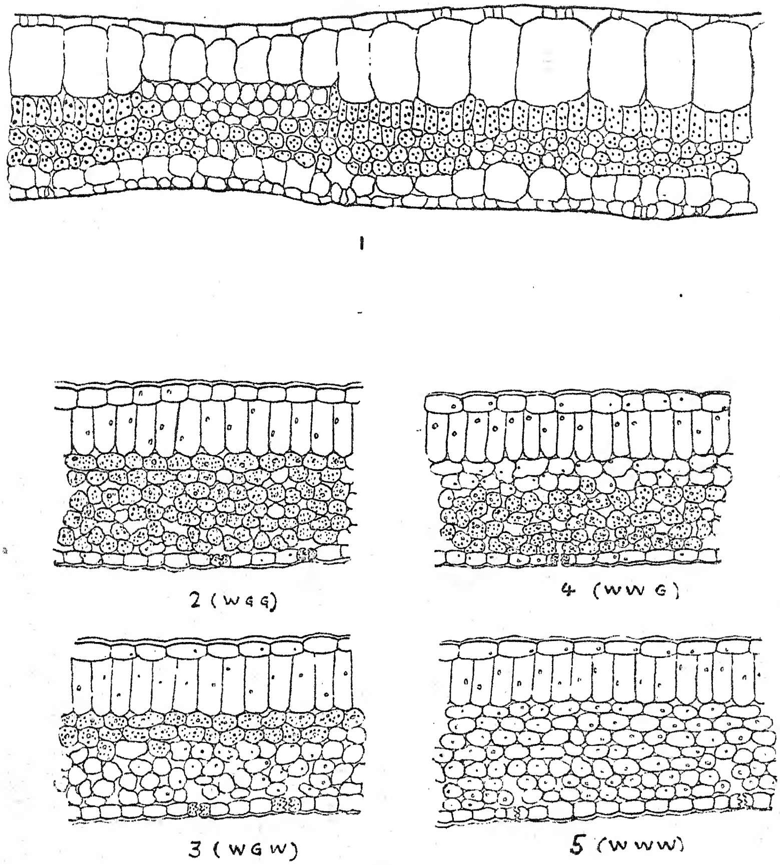
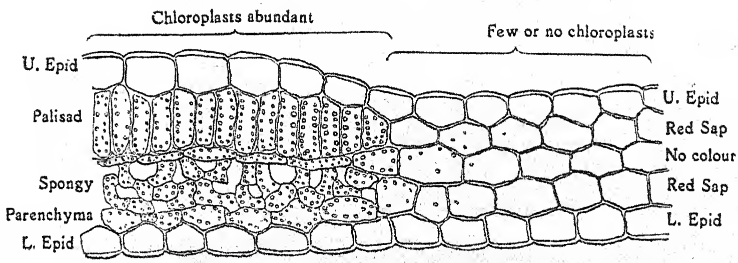
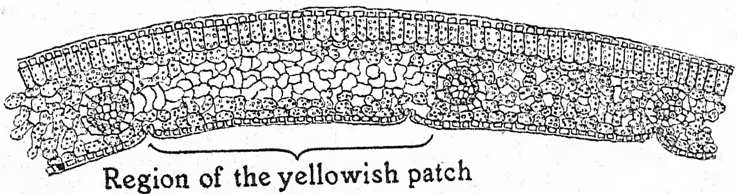


PLATE I


Chloroplasts abundant
Few or no chloroplasts
U. Epid
Palisad
Spongy
Parenchyma
L. Epid
U. Epid
Red Sap
No colour
Red Sap
L. Epid

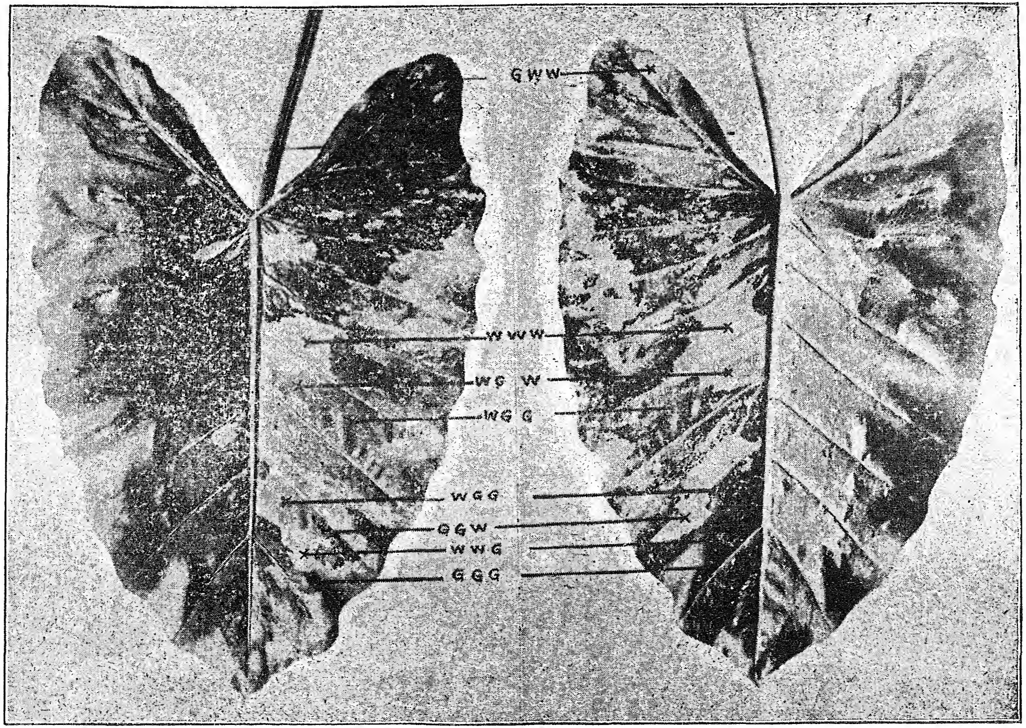
1


Region of the yellowish patch

2

PLATE II.

PLATE III



layers appear to expand ,and embrace the bundle, but to lose its distinctive blue colour.

Breynia rhamncides a wild species common in Madras, affords another and curious type of variegation. In this the leaves, especially towards the ends of the branchlets are mostly white with dark green patches on the upper side and lighter green ones below. The upper and lower patches do not cover each other and a leaf seen against the light shows six different shades of green. The dark green patches of the upper side may be seen even with the naked eye to be definitely raised above general white surface and are due to the presence there of the paliside tissue which is entirely absent elsewhere. Lighter patches on the lower side are due to the absence of chlorophyll in the spongey parenchyma, which, however, unlike the palisade, is of normal structure throughout. In addition to the two departures from the normal structure there is again, as in the variegated *Alocasia* a middle layer which, usually green, is white in some patches. Using the same notation as with Alocasia but marking—when a tissue is absent altogether, we find the following variegations to occur :—

G. G. G.	G. G. W.	G. W. W.
—G. G.	—W. G.	—W. W.
—G. W.		

Conclusion

Variegated leaves of commonly cultivated plants in Madras show that very frequently there are in the leaf not two kinds of mesophyll-tissue as usually stated, but three. And since the chlorophyll may be present or absent independently in these, they appear to be fundamentally distinct. Though in most plants examined, the middle layer was never found to be white unless one or other of the other two layers are, in *Dracaena* the middle layer is white in circular patches while the rest is green.

This has the appearance of the green skin over the white core of Enonymus *Sp.* etc. (Bateson l.c. p. 96), but the sub-epidermal white skin, as distinct from the palisade and spongey tissues as illustrated by Bateson (l.c.) has not been met with.

Explanation of Plate II

Fig. 1. Section through part of the variegated leaf of *Maranta vittata*, showing normal green tissue on right of a white streak.

Fig. 2. Section through leaf of *Dracaena Sp.* Showing absence of chlorophasts in the middle region.

OBSERVATIONS ON THE VOLVOCACEAE OF MADRAS *

BY

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Though there have been some very valuable contributions by algologists like Fritsch (3 and 4), West (6) and (7), Wallich (5), Zeller (10), and others, on the Fresh-water Algal Flora of the Indian region, there has been practically, with the exception of some stray notes, (1, 2, and 8 page 178), no account whatever, either systematic or ecological of the Volvocaceae of India.

Fritsch (3) in his systematic account of the Algal Flora of the Tropics does not refer to the Volvocaceae at all, though records of their occurrence have not been wanting, one of them, (*Pleodorina*), having been recorded by himself (2) from Ceylon. Again West G. S. 9) has recorded some new African species of *Volvox*. He says (8, (page 182), " *Volvox africanus* is known to occur only from the plankton of Albert Nyanza." He has also recorded *Pleodorina illinoisensis* from Madras (8, page 178). He, however, expresses the opinion that the members of this family are on the whole cold water types (8, page 429). It would therefore appear that the members of the Volvocaceae are regarded by European algologists as preeminently cold water types. The primary object of this paper is to draw attention to the very common and abundant occurrence of this family in Madras, a typically semi-dry tropical place. In fact as may be seen below they attain their maximum development only during the warmer parts of the year.

Climatic Details

Madras is quite different from the other parts of India as regards its supply of rain. While all the other parts of India get their maximum supply of rain during the months June to September from the S. W. or Summer Monsoon, the Madras coast districts (from Ganjam to Negapatam) get their chief rain supply during the months October to December from the N. E. or Winter Monsoon. The S. W. Monsoon is only of minor importance on the Madras coast and moreover does not directly bring any rain to Madras. During the breaks in this monsoon on the west coast and towards

* A paper read before the Botanical Section of the Indian Science Congress Meeting at Nagpur, 1920.

the end of it, when its force gets more and more spent, we in Madras get small showers (local showers) at very frequent intervals.

The effect of these small intermittent summer showers is, falling as they do on a parched up soil, merely to wet the surface soil and to fill up the various small depressions in the ground, causing numerous rain water pools all over the place. During these Summer Monsoon months the water in these pools is constantly changing its level. Thus after a fairly good rain the depressions are filled up. During the succeeding rainless days, the level of the water goes down slowly, and in the shallower depressions the water dries up completely. In the deeper pools, however, where the water does not get completely dried up, a fresh rain sends the level up once more. And this process is repeated again and again.

During the N. E. or Winter Monsoon, the rains are heavy and generally continuous. And all the big tanks, streams, ponds, pools, and all low-lying tracts of land get filled up and often overflow. The numerous small rain-water pools that are merely filled up during the Summer Monsoon Season are during this season completely flooded and practically washed out.

The temperature during the S. W. Monsoon months though slightly lower than in May is still fairly high and the sky is generally cloudy and the weather very sultry, the month of September being the most sultry and trying part of the whole year. But with the advent of the N. E. or the Winter Monsoon, the temperature soon goes down and the weather, though the sky is often cloudy, is quite cool and pleasant.

The following table gives the details of the temperature, rainfall and cloud values of the different months of 1919 at Madras :—

1919	Average Max. Temperature for the month.	Average Min. Temperature for the month.	Average Mean Temperature for the month.	Highest Max. Temperature for the month.	Lowest Min. Temperature for the month	Number of rainy days in the month.	Total amount of rain for the month in inches.	Average Cloud value for the month (Over cast Sky=100).
January ...	85°.3	72°.1	78°·7	87°.4	64°.5	1	0·37	36
February ...	87·7	71·4	79·5	93·5	68·4	*Nil.*	*Nil.*	28
March ...	88·7	72·0	80·4	94·9	66·4	2	1·96	13
April ...	93·6	78·7	86·1	98·3	73·7	*Nil.*	*Nil.*	27
May ...	99·3	81·3	90·2	108·2	76·5	2	0·03	33
June ...	98·8	80·8	89·8	105·0	70·2	12	2·49	71
July ...	94·3	78·2	86·2	102·2	73·5	12	6·16	63
August ...	96·5	79·0	87·7	101·1	74·0	8	3·12	66
September ...	91·8	76·9	84·3	99 0	73·3	10	6·78	49
October ...	89·2	76·3	82·7	96·2	73·1	16	10·80	57
November ...	86·2	74·4	8[illegible]·3	90·6	70·5	14	2·83	61
December ...	83·4	72·3	77·8	86·3	67·4	13	6·24	64

Occurrence of the Volvocaceae

The members of this group occur in different kinds of situation; rain-water pools, permanent pools, ponds, ditches, water tubs, paddy-fields, streams, and tanks. They occur throughout the year but attain their greatest development and occur as dominant forms only during the summer monsoon season in the many small rain-water pools that are then formed. During the colder season, though they occur in various situations, they never reach the abundance noticeable in the rain-water pools formed during the summer season, but occur only as subordinate forms, though occasionally *Volvox* or *Pleodorina* may occur for very brief periods as dominant forms in certain waters. I shall now take up the summer monsoon rain-water pools as being the more interesting of the two.

Summer rain-water pools

After the first few summer showers, the water collected in the various rain-water pools all over the place, begins to turn green. And an examination of a drop of this green water shows countless numbers of some member or members of the Volvocaceae. The following genera have been collected by me in these pools during the summer monsoon season:—*Chlamydomonas*, *Carteria*, *Gonium*, *Pandorina*, *Eudorina*, and *Volvox*. All excepting *Volvox* were found in great abundance.

The behaviour of these organisms in the summer rain-water pools is rather interesting. As was pointed out above, the rains during this season are small in quantity and occur at frequent intervals. During the rainless days succeeding a rainy day the water level in the pool goes down gradually and when almost near the bottom a fresh rain comes in and the level of the water goes up once more; and this process is repeated again and again throughout the season.

A few days after the filling up of a pool, the level goes down somewhat and a greenish scum is noticeable on the surface which soon extends deeper and becomes greener. And an examination of a drop of this green water shows large numbers of some member or members of the Volvocaceae (mixed up of course with some diatoms, and some other plankton algae, such as *Scenedesmus*, *Coelastrum*, etc.). As the level goes down, the water gets even more green in colour. But when the pool gets filled up in the next rain, the green colour does not get thinner through dilution but disappears totally. After the level goes down somewhat again as before, a thin green scum is formed and as the level goes down still more the colour deepens and the organisms are seen in large numbers as before. And this interesting process is repeated again and again.

There is yet another interesting behaviour on the part of these organisms. Very early in the mornings the organisms are not so noticeable, but a little later they swim actively all over the water. Towards the middle of the day they recede below again, and towards the evening they float up and form a sort of green mucilaginous film on the surface. In this condition they are generally more quiescent and often are dividing and forming daughter cells or colonies.

Beach Pools

Sand is removed from the Madras Beach for building purposes and fairly deep hollows are formed in the sands very near the shore. During the monsoon seasons a large quantity of rain-water flows down from the Marina Road (which runs parallel to the seashore and is at a higher level than the sandy beach), and fills up these depressions in the sand. Again during the rainy weather the waves are rougher and some sea water also flows over the sandy shore into these pools. These pools, sometime after their formation, both during the summer monsoon and winter monsoon seasons, are soon peopled by large numbers of some member or members of the Volvocaceae. The most interesting feature of these pools is that the wet sand all round the edge of the pool to a distance of a foot or two is quite green. On lightly scraping the surface with a knife I found that the sand was green only near the surface. Microscopical examination of the wet sand revealed a large number of *Chlamydomonas* and other members of the Volvocaceae swimming actively in the thin film of water surrounding the sand particles. Some of this green sand was collected by scraping the surface lightly and shaken with some water. The water became quite green leaving the sand in its normal colour. A drop of this green water examined under the microscope showed the organisms actively swimming about. I found this same preference for the wet banks in other similar situations also. The organisms prefer this situation probably because of better conditions of aeration. In another instance I found that a depression in the beach sands was merely wet at the bottom without any water in it. The surface of this depression was covered by a very thin layer of dry sand which was blown over by the wind. On removing this dry sand lightly with a knife I found the lower layer of sand wet and greenish. I also found that the greenness was confined only to a thin layer at the top and lower down the green colour was absent. I shook some of this green sand with water and found that its greenness was due to a large number of Chlamydomonadine cells which had lost their cilia and were quiescent.

This invasion by the free swimming *Chlamydomonas* of a wet sub-aerial region, in the first place, and, in the second place, its losing its cilia under a comparatively drier condition, suggests a probable method by which some of the sub-aerial unicellular Green Algae might have evolved from some free swimming Chlamydomonadine type.

Genera collected

The following genera have been collected by me at Madras:— *Chlamydomonas*, *Carteria*; *Gonium*, *Pandorina*, *Eudorina*, *Pleodorina* and *Volvox*. The most common ones were *Chlamydomonas* and *Carteria* among the unicellular forms, and *Pandorina* and next *Eudorina* among the coenobial forms. *Gonium* was a rarer form. *Pleodorina* was still rarer. But the rarest was *Volvox*.

These forms I must however point out were always associated with a sprinkling, large or small, of other plankton forms of Algae, and Flagllate (such as *Euglena*, etc.).

One feature which was particularly noticeable in the summer rain-water pools was the complete absence of *Spirogyra* and the other filamentous Green Algae, and the extreme scarcity of the Blue Green Algae.

Enemies of the Volvocaceae

The bottom of the pools very often showed large numbers of amoebae; and these injested a large number of the unicelluler algae during the times when the latter settled down at the bottom. I came across many amoebae, with *Chlamydomonas* in their bodies and I saw some actually in the act of injesting them.

In another pool I found *Pandorina* and *Eudorina* swimming with one or two, sometimes even four or five, small round colourless Protozoons attached to their mucilaginous envelope. On further examination I found that these Protozoons gradually made their way inside and swallowed some of the cells of the colony. Later on they escaped from the colony leaving a big rent in the mucilaginous envelope. Many specimens of *Pandorina* and *Eudorina* were found by me with a big rent in their body and a few of their cells missing.

Another enemy which plays havoc with these forms is a kind of Rotifer. This was found in very large numbers in a tub containing *Pleodorina* and *Eudorina* devouring them in large numbers.

I came across a *Chironomus* larva ("Blood-worm"), devouring large quantities of *Pandorina*. This larva has the habit of constructing out of the materials of its environment such as silt, etc., a kind of case for itself by fastening with the help of a silk-like secretion of its salivary glands. I kept some quantity of live *Pandorina* in a dish. The next morning I found a large number of green cases attached to the

bottom of the dish; and inside each case was a *Chironomus* larva which escaped out on being disturbed with a needle. An examination of a green case showed that it was made up of large numbers of *Pandorina* colonies. The larva on being examined under the microscope showed that it had been feeding on these *Pandorina* colonies; for its alimentary canal was full of them.

Another curious phenomenon noticed by me was a tiny unicellular Blue Green Alga attached to the body of a *Chlamydomonas*. This Blue Green Alga was evidently getting a free ride at the expense of the *Chlamydomonas* and benefiting by the advantages of the locomotion, viz., better aeration and better food supply. Often there was more than one rider on a single *Chlamydomonas*, sometimes as many as five or more. I occasionally came across a few cases where the riders were too many in number for the poor *Chlamydomonas* to carry, which was therefore unable to move at all.

Summary

The following members of the Volvocaceae have been collected from Madras:—*Chlamydomonas*, *Carteria*, *Gonium*, *Pandorina*, *Eudorina Pleodorina* and *Volvox*. The last two are generally very rare forms.

Though these forms may occur in various parts of the year and in various situations, they attain their greatest luxuriance only in the many small rain-water pools formed by the showers of the Summer Monsoon season which at Madras are generally light and irregular, though frequent.

The organisms seem to like light of moderate intensity. They come up sometime after sun-rise and if, in the middle of the day, the sun-light is too strong, recede below and come up again towards the latter part of the day and form a thick green film on the surface. In this condition the organisms are generally very inactive. They sink down again during the night. If the weather is cloudy they do not sink down in the middle of the day, nor do they float up, towards the evening to form a film, but are active throughout the day.

In certain rain-water pools formed in the Madras Beach, these organisms are often found in large numbers on the wet sand around the pool giving it a green colour. This situation is sought by them probably for securing better aeration. In one of these pools where the water had disappeared the wet sand was greenish, and its greenness was due to many quiescent Chlamydomonadine cells without cilia, This invasion of a sub-aerial region by a free swimming aquatic form suggests how some sub-aerial unicellular Green Algae might have originally evolved from some free swimming Chlamydomonadine type.

Certain very small animals were observed to live on some members of this group. The most interesting among them was a *Chironomus* larva (a kind of " blood-worm"), which fed very largely on *Pandorina* colonies and at the same time made a case to live in out of these colonies by fastening a large number of them together by means of a silk-like secretion from its salivary glands.

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NOTE ON CURVATURE OF CUT STEMS OF BRYOPHYLLUM CALYCINUM

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Loeb in 1917 published (1) the results of a series of experiments on curvature induced in cut stems of *Bryophyllum calycinum*, suspended in moist air by threads, one at each end. He found, and published figures in support, that curvature, apparently due to gravity took place, whether leaves were left attached to the plant or not; but much more strongly so, when a leaf near the apical end was left, than when all but a basal leaf were removed. He also found that roots were formed adventitiously, on that region only where the curvature was a maximum, and that root-formation was strongest, when an apical rather than a basal leaf was left. From this, he drew the conclusion, that special root-forming and curvature-producing substances (hormones) are manufactured in the leaf, and passed downwards, but not upwards, along with the products of assimilation.

The experiments described here, were made to test these facts and deductions on plants growing in Madras. Healthy stems of *Bryophyllum calycinum* were used and straight pieces 6 to 8 inches long were cut, and in every case the apical bud and the first visible internode, were removed to prevent continued growth, as was done by Loeb.

All the leaves were removed except one or both apical leaves or, one or both basal leaves, and the pieces suspended over water in a glass chamber. No particular difference was observed, which could be correlated with the presence of one or both leaves, whether at the base or apex: But those with one or both apical leaves curved more than those with basal. (Plate I, figs 1, 2 and 3) Loeb in explaining this as due to the formation of geotropic hormones in the leaf and their passage always down the stem, appears to have overlooked the possibility of the curvature being induced by weight, for no attempt apparently, was made to eliminate this. We found however, that if a third thread was used to support the piece at its centre of gravity or if the pieces were laid on a flat board (fig. 11) no curvature took place. (Compare in Plate I, figs. 8, 9, 10 with 5, 6, 7.)

In order to support the piece without introducing other factors, we attached to the piece near its centre of gravity a fine thread, which after passing over a pulley, supported a pan, in which weights were

placed to counter-balance, the weight of the piece. Plate II, fig. 27 shows how this was done, and it will be seen that no appreciable curvature took place. In the course of the experiment a lessening of the weight, by loss of evaporated water caused the terminal threads to slacken; but at the beginning of the experiment, the weight was evenly distributed and the lack of curvature cannot therefore, be due to any pull upwards, at the centre of gravity.

Since the region of curvature is in the weak still unlignified internodes near the apex (vide figs. 1, 2 and 3) it is clear that the bending moment at the point of curvature due to the comparatively heavy, succulent leaves, will be much greater when these are at the apical end, than if they are at the basal (compare figs. 1 and 2 with 3).

In another series of experiments living stems of *Coleus* still attached to the roots, were laid horizontally, the growing point and the first visible internode, being removed as before. Three pairs of plants were used, and in one of each pair, a pair of apical leaves was left, while in the other one or more near the base. Plate II, fig. 19-26 show the resulting curvature after 24 hours. It will be seen that no definite relationship, can be established between the amount of curvature and the existence or position of leaves Compare Nos. 19 with 20, 23 with 24, 21 and 22 with 25 and 26.

B. The root-forming 'hormones'—Our experiments failed likewise to support Loeb's theory, that root-formation is due to hormones produced in the leaf. Roots were formed freely on the lower side and especially at the region of curvature (figs. 1 and 4) of stems kept damp; but in no apparent relation with the existence or position of leaves. The presence of water, we found to be a much more important factor.

Pieces of stem were placed vertically, in the normal or the reversed position, and one end kept damp, by tying a wet rag round it. In every case roots appeared, whether at the upper or lower end, whether at the apical or the basal. This is exactly in conformity with Klebs results (7).

This occurred also with both isolated and attached leaves of *Bryophyllum*. Roots appeared always in a day or two, at the parts kept wet. Loeb's results (4) of hanging leaves in different positions. which led him to postulate a flow of root-forming substances towards the base of a leaf appear therefore, to have been accidental. In our experiments, leaves were hung in a vertical plane.

(1) by the petiole
(2) by a hole in the apical end
(3) by a hole at one side and
(4) horizontally by threads through two holes in the lamina.

In every case provided the atmosphere was kept saturated, roots appeared with apparently equal facility at any notch.

C. Regeneration. According to Loeb, the growth of roots and shoots, at the marginal notches of a leaf is ordinarily inhibited, by suction of the stem and especially of the growing axillary buds. To verify this :—

(1) A piece of the stem of *Bryophyllum* had one leaf at the basal portion alone left, and it was left in a moist chamber supported in the horizontal position on a board. On the 7th day (Plate I, fig. 11) roots had grown out from the notches of the single leaf, and the opposite bud showed signs of growth. On the 14th day, the bud opposite the basal leaf had fully grown out and several shoots also had appeared from the notches of the basal leaf. Roots had also appeared from the under-side of the basal node.

Now, if really the opposite bud inhibited the growth in the notches of the basal leaf, one would expect that as the opposite bud began to grow, the roots that had grown from the notches of the basal leaf would not have developed any further. On the contrary, they continued to grow, and shoots also appeared from the notches. In short, the growth in the notches of the leaf, progressed side by side with the growth of the opposite bud. Hence, apparently no inhibition had taken place.

(2) Two pieces of the stem of *Bryophyllum*, containing each a single node with only one leaf attached were suspended so that part of the lower leaf was sub-merged in water. After 10 days, it was found that the submerged notches of the lower leaf, in each case, had developed roots, while the opposite bud also was developing. (Plate I, figs. 12 and 13).

(3) A piece of the stem of *Bryophyllum* containing a single node with two leaves attached was arranged so that one of the leaves had a part submerged in water. On the 6th day roots were found to have grown out from the notches of the submerged lower leaf. On the 9th day the bud in the axil of the submerged leaf, as well as the bud in the axil of the opposite leaf had developed. The upper leaf withered and finally fell off, and is therefore not seen in the photograph (Plate I, fig. 18). A root had also grown from the piece of stem.

In this case again, if Loeb's inhibition theory were correct, one would expect that since each of the axillary buds inhibited the development of the opposite leaf, none of the two leaves should have grown any roots in their notches. As a matter of fact, the lower submerged leaf produced roots in its notches and its opposite bud also developed, as also the other axillary bud.

From this we may conclude that neither the stem itself, nor the opposite bud, nor the axillary bud, exert any absolute inhibition, on the development of the marginal notches, and probably affect it very little.

D. Regeneration in leaves still attached to the living plant.—Several normal, erect, healthy plants of *Bryophyllum* were found in which roots and shoots had arisen from the notches of several leaves in contact with the parent plant. It should be mentioned that the preceding week had been a very rainy one. Most of the leaves which had grown shoots at their notches were found to be of a slightly paler green colour, but there were also several green leaves among the number. In none of these stems had the terminal buds been injured or destroyed and they were growing quite well. In the case of one plant where the terminal bud, had been accidentally destroyed, the notches in the leaves had not grown out, but the axillary bud lower down, was starting to grow. The stems of all these plants were quite erect and to all appearance normal. There was no indication of their roots having been injured or of any other pathological condition as suggested by Loeb in his objection (5) to Miss Lucy Braun's very similar observation.

Loeb, indeed contended (1) that "when these leaves are attached to the stem of the whole plant, in the natural condition, they never produce roots and shoots in their notches." The chief factors which he mentions, as tending to prevent the formation of roots and shoots on the leaves when in the natural condition, are (1) the growth of buds on the main stem and (2) root-pressure. His explanation is that the formative materials which are required for active growth, are constantly flowing to the terminal bud from all the other parts of the plant and hence the notches in the leaves have no chance of growing. This explanation does not, however, apply to the instances cited above, as in all those cases, the terminal buds on the main erect stems were quite healthy and active.

Turning now, to the second factor that Loeb mentions, he says that the presence or growth of roots on the main stem inhibits the growth of notches in the leaves because of root-pressure.

It is difficult to conceive how root-pressure can inhibit growth in the notches of the leaf, and Loeb does not explain how it does. In the concluding passages of his paper (1), he says that attempts to induce growth in the notches of the leaves proved futile. He says "the writer left several leaves of the plant submerged in water for months without any results", and therefore concludes that root-pressure is the inhibiting factor.

With a view to find out, whether this was really the case, three

leaves of a plant growing in the ground, which had not grown any roots or shoots in the notches of its leaves, were selected and they were left dipping in water contained in a basin, on the 2nd of December, 1919. Three days later on the 5th of December, roots were found to have grown out from the submerged notches of the leaf, to a length of nearly half an inch. On the 8th December, small shoots also had grown out from the notches.

These observations deny the inhibiting influence of root-pressure and suggest the moist external conditions as accounting for the growth. This is quite in consonance with the fact that the notches in the leaves of the plants had grown out just after a week of heavy rain, although root-pressure must then, presumably, have been considerable, because of the very little transpiration that was possible.

The following experiment appears to be conclusive. A pot plant of *Bryophyllum* was taken and the stem of the plant was cut off leaving only the last basal node with the two leaves attached. The cut end of the stem was sealed firmly with canada balsam, to prevent water from being forced out and resulting in a diminution of root-pressure. The axillary buds of both the leaves, were destroyed. One of the two leaves was left dipping in a basin of water so that part of it was submerged. On the 6th day, roots were found to have grown out in clusters from the notches of the submerged portion of the leaf. Later on small shoots also appeared. Here if, as seems probable, there was considerable root-pressure, the formation of roots and shoots from the leaf-notches was not in any way inhibited.

Summary

Experiments were made to determine whether special root-forming and curvature-producing substances could be recognised as being formed in the leaves, as assumed by Loeb on the results of his observations on *Bryophyllum calycinum*. They were in the first instance a repetition of his experiments, but with certain modifications to eliminate the effects of weight. We find no evidence in support of the theory of special curvature-producing hormones, nor of root-forming substances. On the other hand our observations confirm those of Klebs on the effect of an excess of water on adventitious root-formation.

A further series of experiments on the effect of the growth of an axillary bud on the development of the marginal leaf-notches, failed to confirm Loeb's results. All differences in the rate and amount of growth of roots and shoots from the margins of the leaf, can in our

opinion be sufficiently explained by the suction naturally produced, by a developing organ, on the water and sap locally available, without the assumption of any special inhibitory action. Development of the marginal notches we found to be induced readily by an excess of water, which appeared to be the sole determining cause. Moreover, our observations entirely negatived Loeb's supposition of an inhibitory effect of root-pressure on this development.

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Description of Plates

Plate I

Figs. 1—7. Pieces of Bryophyllum calycinum hung by two threads.

Figs. 8—10. Pieces hung by three threads, the middle thread attached at about the centre of gravity. The positions of the threads, which being invisible against the white background, has been indicated in the original photographs by hand. Apical or basal leaves left as shown. All others removed and terminal bud and first visible internode destroyed.

Fig. 11. Piece of Bryophyllum left on a board. One leaf was left, the others removed as above. The opposite axillary bud has developed but this has not inhibited the growth at the leaf notches. Note no bending.

PLATE I

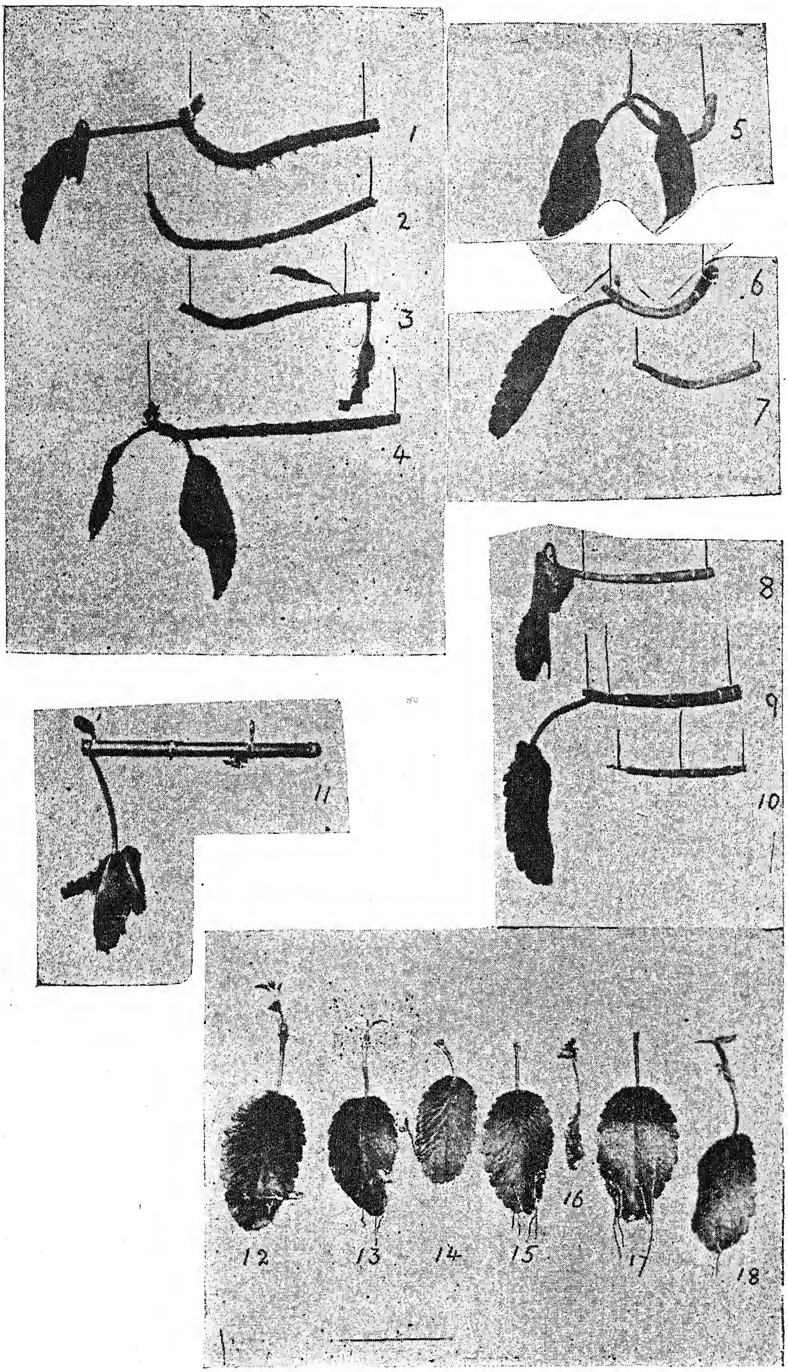
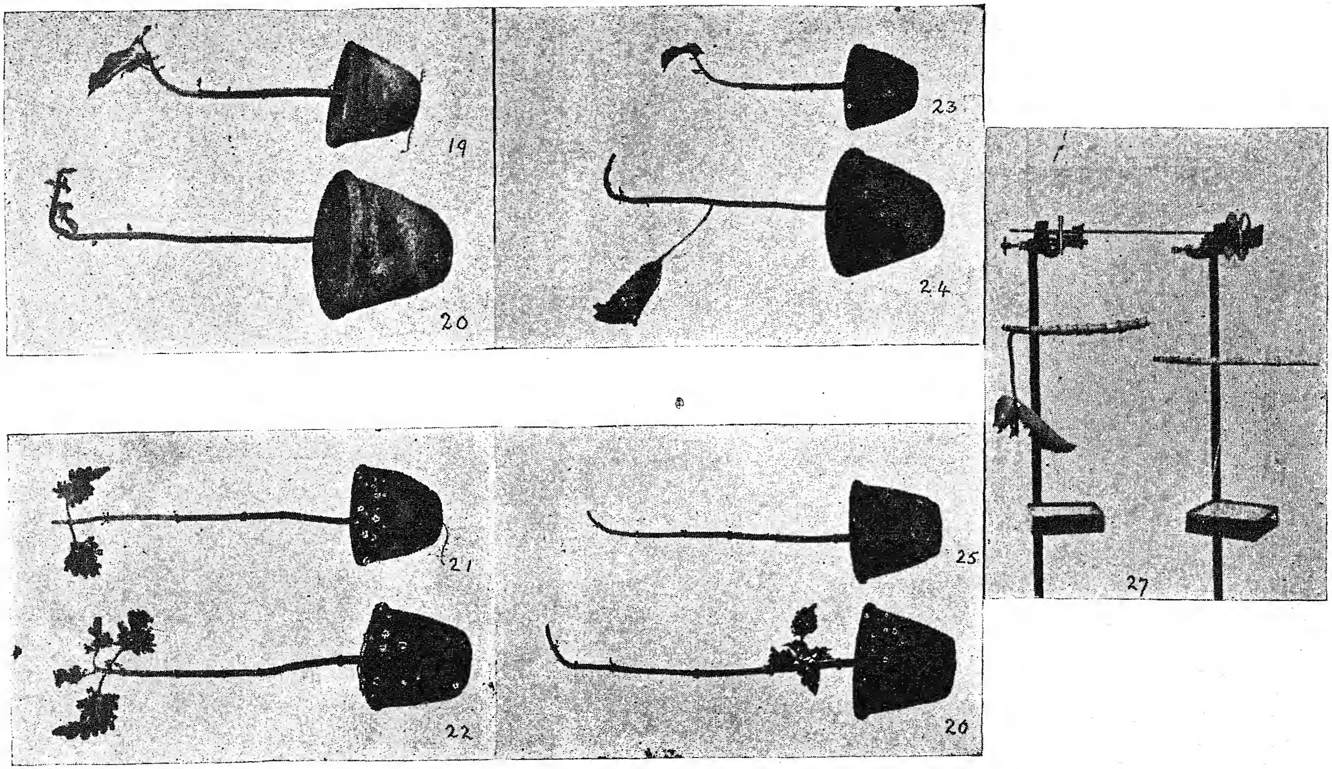


PLATE II



Figs. 12—15 & 17, 18. Leaves of Bryophyllum variously isolated and hung with lower part in water showing development at the marginal notches from the submerged parts.

Nos. 12 & 13. The opposite axillary bud allowed to develope.

No. 14. The opposite axillary bud removed.

No. 15. The stem cut in half longitudinally.

No. 16. Leaf hung dry, no part submerged.

No. 17. No part of stem left attached to leaf.

No. 18. Opposite leaf left attached (but subsequently fell off).

PLATE II

Figs. 19—24. Rooted plants of Coleus bicolor placed horizontally. Photographed after a few days. One or both leaves near the apex or near the base left attached, all others and the terminal bud removed.

Nos. 25 & 26. No leaves left attached. A lateral bud has developed near the base of No. 26.

Fig. 27. The method of hanging pieces by three threads, adopted for Nos. 8, 9 & 10.

CONTRIBUTIONS TOWARDS A FLORA OF BALUCHISTAN

From materials supplied by Col. J. E. B. Hotson, I.A.R.O.

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(*Continued from last issue*)

Urticaceae.

MORUS *L.*

Morus alba *L. Sp. Pl. 986.*—Loc.: Garmkan, 1 mile NE of Panjgur, about 3,125 ft. (no. M 168); Shahdadzai, 72 miles S. of Kalat, 5,100 ft. (no. 148).—Fl. in March 1918.

Vern. Name: Tut (Bal. and Br.).

FICUS *L.*

Ficus bengalensis *L. Hort. Cliff. 471, n. 4.*—Loc.: Las Bela, about 700 ft. (no. 399A); Pasni, sea level (no. M47).—Fr. in Oct. 1917.

Vern. Name: Kark (Bal.).

Ficus palmata *Forsk. Fl. Aeg. Arab. 179.*—Loc.: Jebri, 147 miles SSW of Kalat, 3,850 ft. (no. 224); Gajar, 165 miles SSW of Kalat, 3,450 ft. (no. 224A).

Vern. Names: Hanjir, Anjir (Br. and Bal.).

Ficus carica *L. Sp. Pl. 1059.* var. **rupestris** *Hausskn.*—Loc.: Nag (W. Kolwa), about 83 miles E. by N. of Turbat, about 2,300 ft. (no. M237).—Fl. in April 1918.

Vern. Name: Anjir, Hanjir (Bal. etc.).

FORSKOHLEA *L.*

Forskohlea tenacissima *L. Mant. 72.*—Loc.: Sor, about 74 miles S. of Panjgur, 2,300, ft.; Zidi, 15 miles ESE of Khozdar, about 3,600 ft. (no. 256A.); Pirandar, 205 miles SSW of Kalat, about 1,900 ft. (no. 256); Sor (Kil Kaur) about 74 miles S. of Panjgur, 2,300 ft. (no. M215).—Fr. in April 1918.

Vern. Name: Liguri, (Br.).

Salicaceae.

SALIX *L.*

Salix acmophylla *Boiss. Diagn. VII, 98.*—Loc.: Sitani, 59 miles S. of Kalat, 5,300 ft. (no. 118).

Vern. Name: Ghot (Br.), Bhed (Bal.).

Salix angustifolia *Willd. Sp. Pl. IV, 699.*—Loc.: Kuchkan (Kharan) about 30 miles NNW of Mangeli (Jhalarwan) about 3,300 ft. (no. M229).

Vern. Name: Bhed (Bal.), Ghet (Br.).

POPULUS *L.*

Populus euphratica *Oliv. Voy. III, 449, t. 45, 46.*—Loc.: Shahdadzai, 72 miles S. of Kalat, 5,300 ft. (no. 144); below Bhani, 131 miles SSW of Kalat, almost 4,000 ft. (no. 206); Awwaran, 26° 24′ N, 65° 12′ E, about 1,750 ft. (no. M280).

Vern. Name: Patk (Bal. and Br.), Bahan (Br. Bal., Sind, etc.).

Populus alba *L. Sp. Pl. 1034.*—Loc.: Shahdadzai, 72 miles S. of Kalat, 5,100 ft. (no. 146).

Vern. Name: Ispidar (Br.).

Orchidaceae.

Epipactis consimilis *Wall. Cat. no. 7403.*—Loc.: Near Chambar (no. M 261B); Anjiri Kaur, S. of Chambar (Kolwa), about 2,150 ft. (no. M261).—Fl. and Fr. April 1918.

Iridaceae.

GLADIOLUS *L.*

Gladiolus segetum *Ker.-Gawl. in Bot. Mag. t. 719.*—Loc.: Panjgur, about 3,100 ft. (no. M150, M150A); Khudabadan, ¼ mile N. of Panjgur, about 3,100 ft. (no. M177F).—Fl. in March 1918.

Vern. Name: Titmatan (Panjguri Bal.), Sarkok (Zamarani Bal.). Sarkako (Bal.).

Liliaceae.

ASPARAGUS *L.*

Asparagus capitatus *Bak. in Journ. Linn. Soc. XIV, 607.*—Loc.: Nal, 27° 41′ N, 66° 13′ E, about 3,800 ft. (no. 205B); Teghab, 107 miles S. of Kalat, 4,150 ft. (no. 179); Bhani, 131 miles SSW of Kalat, 4,000 ft. (no. 205A).—Fl. in Sept. 1917.

Vern. Name: Avishk (Bal. and Br.), Khakshir (Pers.).

Asparagus racemosus *Willd. Sp. Pl. II, 153.*—Loc.: Hodal Pass (S. side), about 85 miles S. of Panjgur, 2,900 to 2,400 ft. (no. M224).—Fl. in April 1918.

Vern. Name: Kalirkah.

ASPHODELUS *L.*

Asphodelus tenuifolius *Cavan. in Ann. Cienc. Nat. III, 46, t. 27.*—Loc.: Under Harboi, 15 miles ESE of Kalat, 8,300 ft. (no. 49D); Ghulamani Bent, 23 miles N. of Pasni, about 100 ft. (no. M49); 5 miles N. of Mand, about 1,000 ft. (no. M49B); Turbat, 63° 4′ E, 25° 58′ N, about 6,000 ft. (no. M49A).—Fl. in Feb. 1918, Fr. in Feb. and March 1918.

Vern. Name: Serishako (Br.), Pimalo (Bal.).

EREMURUS *Bieberst.*

Eremurus Persicus *Boiss. Diagn. VII, 119.*—Loc.: Harboi, 18 miles ESE of Kalat, 9,000 ft. (no. 49A, 49B).—Fr. in Aug. 1917.

Uses: The leaves are cut up and boiled with oil and ghi, and eaten as a vegetable. (Hotson).

Vern. Name: Sirishako (Br.)

ALLIUM *L.*

Allium scabrellum *Boiss. & Buhsi in Nouv. Mem. Soc. Nat. Mosc. XII (1860) 215.*—Loc.: Harbud, about 53 miles E. of Panjgur, about 3,700 ft. (no. M49C).—Fl. and fr. in April 1918.

Vern. Name: Pimalo, Pimalhe (Br. and Bal.).

Allium? fistulosum *L. Sp. Pl. 301.*—Loc.: Sorgaz on Khozdar River, about 9 miles S. of Khozdar, about 3,800 ft. (no. 363).

Vern. Name: Nargiz.

TULIPA *L.*

Tulipa sp. Loc.: Harboi, 18 miles ESE of Kalat, 9,000 ft. (no. 30). —Fr. in Aug. 1917.

Uses: Eaten by sheep. (Hotson).

Vern. Name: Gwarckh (Br.).

Juncaceae.

JUNCUS *L.*

Juncus glaucus *Ehrh. Beitr. VI, 83.*—Loc.: Gwambok, about 50 miles SE of Panjgur, abont 2,700 ft. (no. M25).—Fr. in Feb. 1918.

Vern. Names: Kul (Bal.).

Juncus maritimus *Lam. Encycl. III, 264.*—Loc.: Panjgur (no. M120C).—Fl. and fr. in May 1918.

Vern. Name: Samar (Bal. and Br.), Samagram, (Panjguri).

Juncus punctorius *L. f. Suppl. 208.*—Loc.: Surab (Jhalarwan). 28° 29′ N, 66° 16′ E, about 7,500 ft. (no. M374).—Fl. in June 1918.

Juncus lampocarpus *Ehr. Calam. n. 126.*—Loc.: Spring on Harboi, 18 miles ESE of Kalat, 8,600 ft. (no. 66).—Fr. in Aug. 1917.

Vern. Name: Dirna Chab (Dir = water), (Br.).

Palmae.

PHOENIX *L.*

Phoenix dactylifera *L. Sp. Pl. 1188.*—Loc.: Chib (Buhda), 63° 8′ E, 26° 19′ N., about 1,600 ft. (no. M123); Nag (W. Kolwa), about 83 miles E by N of Turbat, about 2,300 ft. (no.M123); Chhuttok, 9 miles S. of Kalat, 4,500 ft. (no. 176).—Fl. in March and April 1918.

Vern. Name: Pish (Machi), Hosh (Bal.).

NANNORHOPS *H. Wendl.*

Nannorhops Ritchieana *H. Wendl. in Bot. Zeit. (1879) 148.*—Loc.: Hills S. of Chambar (Kolwa), 26° 9′ N, 64° 42′ E, about 1,900-2,200 ft. (no. M252).

Vern. Names: Pish-Redag (Bal.).

Typhaceae.

TYPHA *L.*

Typha angustifolia *L. Sp. Pl. 971.*—Loc.: Shahdadzai, 72 miles S. of Kalat, 5,100 ft. (no. 145); Bhani, 131 miles SSW of Kalat, 4,000 ft. (no. 145A). Fr. in Aug. 1917.

Uses: The heads when ripe are used for stuffing cushions and pillows. (Hotson).

Vern. Name: Kul, Lukh (Br. and Bal.), Lukh (Pers.).

Naiadaceae.

POTAMOGETON *L.*

Potamogeton oblongus *Viv. Fl. Ital. 2, t. 13.*—Loc.: Chib (Buhda), 63° 8′ E, 26° 19′ N, about 1,600 ft. (no. M126).—Fr. in March 1918.

Alismaceae.

TRIGLOCHIN *L.*

Triglochin palustre *L. Sp. Pl. 338.*—Loc.: Spring in Harboi, 18 miles ESE of Kalat 8,600 ft. (no. 70A).—Fl. in Aug. 1917.

Gramineae

ECHINOCHLOA *Beauv.*

Echinochloa Crus-galli *Beauv. Agrost. 53, t. 11, (1812).*—Loc.: Khozdar, 27° 48′ N, 66° 37′ E, about 4,100 ft. (no. 312A).—Fr. in Sept. 1917.

Vern. Name: Samo (Bal.).

Echinochloa colona *Link Hort. Berol. II, 209.*—Loc.: Tegab, 107 miles S. of Kalat, 4,150 ft. (no. 191). Fl. and fr. in Aug. 1918.

Vern. Name: Samako (Bal.).

PANICUM *L.*

Panicum rugosum *L. Mant. I, 29.*—Loc.: Near Ornach, about 3,400 ft. (no. 312). Fr. in Sept. 1917.

Vern. Name: Samo (Bal. and Br.).

Panicum ? miliaceum *L. Sp. Pl. 58.*—Loc.: Kalat, about 6,350 ft. (no. M396D). Fr. in July 1918.—Probably cultivated.

Panicum antidotale *Retz Obs. IV, 17.*—Loc.: Rekin (Avaran, Kolwa), 26° 24′ N, 65° 12′ E, about 1,750 ft. (no. M286); Kochan, 122 miles SSW of Kalat, 4,175 ft. (no. 197); Dokop, about 60 miles W. of Turbat, 700 ft. (no. M16); Rodkan (W. Kolwa), about 85 miles E. of Turbat, about 1,800 ft (no. M16A); Chhuttok, 90 miles S. of Kalat, 4,550 ft. (no. 168).—Fl. and fr. in March 1917, April 1918, Dec. 1917.

Vern. Name: Dariagi (Mand Bal.), Gomaz, Gumazg (Bal.), Bershonk.

SETARIA *Beauv.*

Setaria glauca *Beauv. Agrost. 51.*—Loc.: Surab, 43 miles S. of Kalat, 5,750 ft. (no. 111). Fl. and fr. in Aug. 1917.

Setaria viridis *Beauv. Agrost. 51.*—Loc: Kalat, about 6,350 ft. (no. M396).—Fr. in July 1918.

PENNISETUM *Pers.*

Pennisetum dichotomum *Del. Fl. Aegypt. 159, t. 8. f. 1.*—Loc.: Dekop, 10½ miles E. of Mand, about 650 ft. (no. M70); Rekin (Awaran, Kolwa), 26° 24′ N, 66° 12′ E, about 1,750 ft. (no. M 16 B); Kochan, 121 miles SSW of Kalat, 4,175 ft. (no. 196).—Fl. and fr. in March and April 1918, Aug. 1917.

Vern. Name: Barshonk, Haden (Br.), Dramshokh (Bal.), Gomaz (Bal. and Br.).

Pennisetum orientale *Rich. in Pers. Syn. I, 72.*—Loc.: Hodal Pass (N. side), about 80 miles, S. of Panjgur, 2,200-2,900 ft. (no. M44A).—Fl. and fr. in April 1918.

Vern. Name: Harnal (Bal.).

Pennisetum cenchroides *Rich. in Pers. Syn. 1, 72.*—Loc.; Wahir, 27 miles SSW of Khozdar, about 4,200 ft. (no. 153A); Mangali (Jalarwan), 26° 45′ N, 65° 21′ E, about 2,600 ft. (no. M284A); Dokop, 10½ miles E. of Mand, about 650 ft. (no. M66); Zahren Kahur, 16 miles N. of Parsni, about 200 ft. (no. M 43).—Fl. and fr. in Feb. and March 1918, Sept. 1917.

Vern. Name: Gandil (Gindel less correct) (Br.), Mazardum (Bal.), Putar (Bal. and Br.).

TRAGUS *Haller.*

Tragus racemosus *Scop. Intro. Hist. Nat. 73.*—Loc.: Summit of Burida Pass, 140 miles SSW of Kalat, about 4,250 ft. (no. 212A); Wahir, 25 miles SW of Khozdar, 4,200 ft. (no. 371).—Fl. and fr. in Aug. and Oct. 1917.

Vern. Name: Mashna (Habi Br.).

IMPERATA *Cyrill.*

Imperata arundinacea *Cyrill. Pl. Rar. Neap. Fasc. II, 26, t. 11.*—Loc.: Khudabadan, ¼ mile N. of Panjgur, about 3,100 ft. (no. M195).—Fl. and fr. in March 1918.

Vern. Name: Drug (Bal.)

ERIANTHUS *Michx.*

Erianthus Griffithii *Hook f. in Hook. f. Fl. Brit. Ind. VII, 122.*—Loc.: Gwambuk, about 50 miles SE of Panjgur, about 2,700 ft. (no. M 24).—Fl. and fr. in Feb. 1918.

Vern. Name: Kash (Bal. and Br.).

Erianthus Ravennae *Beauv. Agrost. 14.*—Loc.: Bhani, 131 miles SSW of Kalat, 4,000 ft. (no. 165 A); Chhuttok, 90 miles S. of Kalat, about 4,550 ft. (no. 165).—Fl. and fr. in Aug. 1917.

Vern. Name: Kik (Bal. and Br.).

ELIONURUS *Humb & Bonpl.*

Elionurus hirsutus *Munro ex Benth. in Journ. Linn. Soc. XIX (1881) 68.*—Loc.: Rekin (Awaran, Kolwa), 26° 24′ N, 65° 12′E, about 1,750 ft. (no. M212C)—Fl. and fr. in April 1918.

Vern. Name: Gorkah (Bal. and Br.).

ANDROPOGON *L.*

Andropogon foveolatus *Del. Fl. Egypt. 16a, t. 8, f. 2.*—Loc.: Rekin (Awaran, Kolwa), 26° 24′ N, 65° 12′ E, about 1,700 ft. (no. M287); Zahrew Kahur, 16 miles N. of Pasni, about 200 ft. (no. M40A).—Fl. and fr. in Feb. and April 1918.

Vern. Name: Sibr, Gandil (Bal. and Br.).

SORGHUM *L.*

Sorghum halepense *Pers. Syn. I, 101.*—Loc.: Quetta.

CHRYSOPOGON *Trim.*

Chrysopogon serrulatus *Trim. in Mem. Acad. Petersb. ser. 6, 11 (1833) 318.*—Loc.: Rekin (Awaran, Kolwa), 26° 24′ N, 65° 12′ E, about 1,750 ft. (no. M284). Fl. and fr. in April 1918.

Vern. Name: Potar (Bal.).

DICANTHIUM *Willem.*

Dicanthium annulatum *Stapf.*—Loc.: Nagak (W. Kolwa), about 87 miles E. by N. of Turbat, about 2,400 ft. (no. M230); Khozdar (no. 312A).—Fl. and fr. in April 1918.

Vern. Name: Samo.

CYMBOPOGON *Sprengel.*

Cymbopogon Iwarancusa *Schult. Mant. II, 458.*—Loc.: Kochan, 122 miles SSW of Kalat, 4,175 ft, (no. 162A); Harbud, about 155 miles E. of Panjgur, about 3,700 ft. (no. 213B); Awaran, Kolwa, 26° 24′ N, 65° 12′ E, about 1,750 ft, (no. M281); Drakalo, 12 miles SSW of Wad, about 4,900 ft. (no. 162B.).—Fl. and fr. in April 1918, Aug. and Sept. 1917.

Uses: When a man has fever, a large quantity of this grass is collected and made into a bed. He lies on it and at once begins to sweat. The roots are said to be sweet-scented. (Hotson).

Vern. Name: Have (Br.), Haveh (Br. and Bal.).

Cymbopogon Martini *Stapf.*—Loc.: Kanoji, 47 miles N. of Las Bela, about 3,200 ft. (no. 386).—Fl. and fr. in Oct. 1917.

Vern. Name: Putar (Br.).

ARISTIDA *L.*

Aristida Adscenscionis *L. Sp. Pl. 82 (excl. Syn. Sloane.).*—Loc.: Rekin Awaran, (Kolwa) 26° 24′ N, 65° 12′ E, about 1,750 ft. (no. M285).—Fl. and fr. in April 1918.

Vern. Name: Lash (Br.)

Aristida mutabilis *Trin. & Rupr. in Mem. Acad. Petersb. ser. 6, VII (1849) 150 (excl. var. aequilonga).*—Loc.: Gili (Jar.), about 100 miles SSW of Kalat, about 2,000 ft. (no. 59A).—Fl. and fr. in Sept. 1917.

Vern. Name: Gadbahi (Br.).

STIPA *L.*

Stipa orientalis *Trin. ex Ledeb. Fl. Alt. I, 83.*—Loc.; Harboi, 18 miles ESE of Kalat, 9,000 ft. (no. 34).—Fl. and fr. in Aug. 1917.

Uses.—: Eaten by animals.

Vern. Name: Gasht (Br.).

Stipa pennata *L. Sp. Pl. 78.*—Loc.: Chhuttok, 90 miles S. of Kalat, about 4,550 ft. (no. 162); Gwambuk, about 50 miles SE of Panjgur, about 2,700 ft. (M 29).—Fl. and fr. in Aug. 1917.

Uses: Reputed to be the best grazing grass on the hills (Hotson).

Vern. Name: Haveh (Br.), Mazh (Bal.).

POLYPOGON *Desf.*

Polypogon monspeliensis *Desf. Fl. Atl. I, 66.*—Loc.: Nag (W. Kolwa), about 83 miles E. by N. of Turbat, about 2,300 ft. (no. M24B); Mazarjuh (Gidar, Jalarwan), 28° 11′ N, 66° 2′ E, about 5,200 ft. (no. M254); Panjgur, about 3,200 ft. (no. M124A); Chib (Buhda) 63° 8′ E. 26° 19′ N, about 1,600 ft.—Fl. and fr. in March, April and June 1918.

Vern. Name: Jaudal (Bal. and Br.), Narmo (Kechi, Makrani Bal.), Phulko (Panjguri Bal.)

SPOROBOLUS *Br.*

Sporobolus arabicus *Boiss. Diagn. Pl. Or. ser. I, XIII, 47.*—Loc.: Teghab, 107 miles S. of Kalat, 4150 ft. (no. 192); Nagak (W. Kolwa), about 87 miles E. by N. of Turbat, about 2,400 ft. (no. M 229). — Fl. and fr. in April 1918, Aug. 1917.

Vern. Name: Lash (Br. and Bal.).

AGROSTIS *L.*

Agrostis verticillata *Vill. Fl. Delph. 74.*—Loc.: Iskalku, 7 miles E. of Kalat, 7,500 ft. (no. 86); Khudabadan, ¼ mile N. of Panjgur, about 3,100 ft. (no. M 189).—Fl. and fr. in March 1918, Aug. 1917.

Vern. Name: Tusg (Bâl.).

AVENA *L.*

Avena Cavanillesii *Koch Syn. Fl. Germ. ed. 1, 1, 797.*—Loc.: Quetta.

CYNODON *Pers.*

Cynodon dactylon *Pers. Syn. I, 85.*—Loc.: Panjgur (no. M428). Kalat, about 6,350 ft. (no. M 396 A). Fl. and fr. in May and July 1918;

Vern. Name: Shez (Panjguri Bal.), Milinu.

CHLORIS *Sw.*

Chloris villosa *Pers. Syn. I, 87.*—Loc.: Chhuttok, 99 miles S. of Kalat, about 4,550 ft. (no.161); summit of Burida Pass, 140 miles SSW of Kalat, about 4,250 ft. (no. 212).—Fl. and fr. in Aug. 1917.

Vern. Name: Gashd, Mashna Chab (Br.), Kohi Chab (Bal.).

ELEUSINE *Gaertn.*

Eleusine flagellifera *Nees in Linnaea XIV* (1842) 220.—Loc.: Zahrin Kahur 16 miles N. of Pasni, about 200 ft. (no. M 40). Fl. and fr. in Feb. 1918.
Vern. Name: Gandil (Bal. and Br.).

ARUNDO *L.*

Arundo Pliniana *Turra, Farset.* 11.—Loc.: Kori Kaur, W. of Ornach (no. 310)—Fl. in Sept. 1917.
Vern. Name: Nal.

PHRAGMITES *Trin.*

Phragmites communis *Trin. Fund. Agrost. 134.*—Loc.: Ornach, 3,080 ft. (no. 123A).—Fl. and fr. in Sept. 1917.
Vern. Name: Nalinchk.

KOELERIA *Pers.*

Koeleria phleoides *Pers. Syn. I, 97.*—Loc.: Quetta.

ERAGROSTIS *Beauv.*

Eragrostis papposa *Steud. Nom. ed. 2, I, 564.*—Loc.: Surab, 43 miles S. of Kalat, 5,750 ft. (no. 112); Quetta; Kalat, abount 6,350 ft. (no. M 396C).—Fl. and fr. in July 1918, Aug. 1917.

DESMOSTACHYA *Stapf.*

Desmostachya bipinnata *Stapf in Dyer Fl. Cap. VII, 632 (1900).*—Loc.: Shahdadzai, 72 miles S. of Kalat, 5,100 ft. (no. 135B). —Fl. and fr. in Aug. 1917.
Vern. Name: Drak (Br. etc.).

AELUROPUS *Trin* (partim).

Aeluropus arabicus *Steud. Nom. ed. 2, I. 30.*—Loc.: Karki, 21 miles NE of Buhda, about 1,600 ft.
Vern. Name: Kandar (Br. and Bal.), Baun (Cechi Br).

SCHISMUS *Beauv.*

Schismus marginatus *Beauv. Agrost. 74, t. 15, f. 4.*—Loc.: Quetta.

AGROPYRUM *J. Gaertn.*

Agropyrum repens *Beauv. Agrost. 102.*—Loc.: Kalat, about 6,350 ft. (no. M396).—Fl. and fr. in July 1918.
Vern. Name: Milinj (Br.)

Agropyrum longe-aristatum *Boiss. Fl. Or. I, 660.*—Loc.: Turbat, 63° 4′ E, 25° 58′ N, about 600 ft. (no. 55).—Fl. and fr. in Feb. 1918.

Gnetaceae.

EPHEDRA *L.*

Ephedra foliata *Stapf in Denkschr. Mathem.-Naturw. Classe Kais. Akad. Wiss. (1889), 49, t. 2 and 10, f. 1—11.*—Loc.: Pusht Kuh

(Kharan), about 26° 57′ N, 65° 12′ E, about 3,500 ft. (no. M302A).—Fr. in April 1918.

Vern. Name: Humuk (Bal.).

Ephedra intermedia *Stapf l. c. 61, t. 2 and 15, f. 1—9.*—Loc.: Harboi, 18 miles ESE of Kalat, 9,000 ft. (no. 23); Kalgali Jaur (Kharan), 22° 1′ N, 65° 54′ E, about 5,400 ft. (M348); Hushtar Rahi Kaur, 160 miles S. of Kalat, about 3,700 ft. (no. 304).—Uses: Used for tanning leather.

Vern. Name: Narom, Naromb (Br.), Hom (Bal.).

Ephedra nebrodensis *Stapf l. c. 77, t. 3, XX. f. 1—7.*—Loc.: Bhani, 131 miles SSW of Kalat, 4,000 ft. (no. 205).

Vern. Name: Avishk (Br.).

Coniferae.

JUNIPERUS L.

Juniperus macropoda *Boiss. Fl. Or. V. 709.*—Loc.: Harboi, 18 miles ESE of Kalat, 9,000 ft. (no. 18, 18A, 18B).—Fr. in Aug. 1918.

Uses: The berries are boiled and the juice is very good in diseases of the chest, causing profuse perspiration. They are greatly exported to Sind for use as medicine. The leaves are eaten by camels. and the berries by chikor.

THE END

CURRENT LITERATURE.

Physiology

MacDougal, D. T., H. M. Richards, & H. A. Spoehr. Basis of succulence in plants. *Bot. Gaz. 67: 405-416. 1919.*

Succulence is defined as an exaggerated development of the parenchymatous regions of the plant. The masses of thin-walled cells become permanently distended and turgid. Succulent plants are characteristic of deserts and of salty areas along seashores. All attempts to connect the origin of succulence with the presence of salts in the soil, or with high acidity in the plant tissues, or with purposeful development of water-storage tissue have been inadequate.

The authors found a plant, *Castilleja latifolia*, becoming a succulent on dry bluffs along the coast of California, but producing thin leaves in places with better water supply. The thin leaves show double the acidity of the succulent leaves. From a large series of experiments, analyses, and observations, they conclude that with scarcity of water in the cells, polysaccharides are transformed into pentosans. The polysaccharides show little imbibation, while the pentosans show an enormous capacity to imbibe water and to swell. The result is the production of a succulent plant, and as the reaction is irreversible, the succulence is permanent. They believe that the high acidity is nothing more than a characteristic of plants which have a metabolic complex favorable to the formation of pentosans, and to the development of succulence under certain conditions of environment.

WINFIELD DUDGEON.

Gray, John and George J. Pierce. The influence of light upon the action of stomata and its relation to the transpiration of certain grains. *Am. Jour. Bot. 6: 131—155. 18 figs. 1919.*

It is commonly accepted that stomata act as the main regulators of transpiration, and that their movement is due to changes in the turgidity of the guard cells. From a study of a number of cultivated and wild grasses the authors conclude that while "turgidity of the guard cells is a necessary factor in producing and maintaining their elasticity......the direct and indispensible agent in controlling the opening and closing of the stomata is sunlight, which acts as a stimulus on the guard cells themselves." They find that the stomata do not maintain sufficient turgidity to be affected by light when the soil moisture falls below a certain specific amount, but no matter how well watered the plant is, the stomata do not open on cloudy days. When sufficient moisture is present, the opening of the stomata follows very closely the incidence of sunlight.

Their method was to examine the leaves under a microscope while still attached to the growing plant. This involves minimum disturbance of the stomata, and permits repeated examination of the same leaf, and even of the same stomata, under varying conditions.

WINFIELD DUDGEON.

Small, James "The Chemical Reversal of Geotropic Response in Roots and Stems"—*The following abstract of a paper read before the Linnean Society, March 18, 1920, is taken from the minutes of the meeting.*

When roots are placed horizontally in a moist atmosphere rendered very faintly alkaline by ammonia vapour they tend to grow upwards. When stems are treated in a similar way with acetic acid vapour they tend to grow downwards.

These experiments, illustrated by photographic lantern-slides, form preliminary confirmation of the following theory of geotropic curvature, which has been elaborated as a co-relation of previous work on the electrical conductivity of roots with data accumulated by other investigators.

The outer zone of the protoplasm in the cells of the apical meristem is an emulsion with a continuous phase of colloidal aqueous solution and a disperse phase of protein or protein-lipoid particles, which show Brownian movement and carry an electropositive charge when the hydrion concentration of the continuous phase is higher than the isoelectric point of the vegetable proteins, or an electornegative charge when that hydrion concenteration is lower than the isoelectric point of the proteins. The continuous phase or medium in the root is relatively acid and that in the stem is relatively alkaline.

Creaming of the emulsion under the influence of gravity causes differences of potential in the apex of root and stem, which produce electric currents. These produce differences in permeability, turgor, and rate of growth. The direction of these currents is determined by the positive charge in the root and the negative charge in the stem with corresponding downward or upward curvature.

The reversal of curvature in the experiments is due to the reversal of the electrical charges on the particles of the disperse phase, which is caused by the changes in the relation of the hydrion concentrations to the isoelectric point of the proteins. This theory explains practically all the details of known geotropic phenomena, including the orientation of the secondary and tertiary branches of roots and stems. It has very wide applications to cytolysis, the stimulus response ratio of the Weber Law, acid-tolerant and calcifuge species, immunity from and liability to attack by bacteria and fungi, the development of intumescences, the effects of acids, alkalies, and salts on plants and animals in general and on the permeability of protoplasm in particular, and possibly also to epharmonic variations. It provides on explanation, not only for the normal polarity of growth in the plant, but also for the changes in geotropic response and in colour which occur in flower-buds and other organs.

Indications have been obtained that the Co^2 balance in stem and root is the chief factor governing the differentiation in hydrion concentration, and also that phyllotaxis can be explained in terms of the potential differences postulated.

Heredity

White, Orland E. Breeding new castor beans. *Jour. Heredity 9: 195—200. 5 figs. 1918.*

The author calls attention to the desirability of developing improved

strains of the common castor bean (*Ricinus communis*). The paper is of great interest because it calls attention to the fact that the plant is very favorable material for genetical work. There is a large number of contrasting and easily recognizable characters, such as color of stem, foliage, and seed coats; presence or absence of glaucescence; dehiscent or indehiscent capsules; height of plant; size and compactness of fruiting spike; time of maturity; size and shape of seeds; oil and "acid" content of seeds, etc. The ordinary Indian field presents a hopeless mixture of these characters. Since the plant is monoecious, and the staminate and carpellate flowers are segregated in the inflorescence, it is quite easy to conduct controlled pollination experiments. Ricinus should prove very useful for demonstrating to college classes the outstanding facts of inheritance.

WINFIELD DUDGEON.

Hepaticae

Campbell, D. H. Studies in some East Indian Hepaticae. (Calobryum Blumei). *Annals of Botany, Jan. 1920.*

The writer describes the structure and development of the curious liverwort *Calobryum Blumei*. The plant has a much branching prostrate stem like a rhizome without rhizoids which gives rise to erect aerial leafy shoots sympodially. The leaves are arranged radially in three rows, though one of the rows has often smaller leaves. The leaves are thicker at the base than higher up. The stem grows by means of a tetrahedral apical cell, and it has a large celled cortex and a central cylinder with narrow and elongated cells. Mucilage hairs are present in almost all parts of the plant. Antheridia and archegonia occur separately in clusters and are surrounded by large leaves. Development of both is very variable. That of the antheridium is as a rule astonishingly like the development of the archegonium. The stalk of the antheridium consists of four rows of cells and the structure of the latter is like that of other liverworts. The development of the sperms is as usual in liverworts. The apical cell is used up in the formation of the archegonia. The venter is formed of two layers of cells in the mature archegonium, and the neck consists of four rows of cells. The conclusion is drawn that the male and the female organs are homologous. The development of the embryo, so far as seen, was like that in the other Jungermanniales. There is a long seta, and an elongated capsule with a single layer of cells forming its wall and a beak at the apex. Dehiscence by a long slit along one side. Elaters with a double spiral. There is a massive calyptra.

The conclusion is that the separation of *Calobryum* along with *Haplomitrium* into a family, the Calobryaceae, is entirely justified. The distribution of the genus shows that it was more generally distributed in former times.

S. R. K.

Mosses

Brown, Mabel M. The development of the gametophyte and the distribution of sexual characters in Funaria hygrometrica. *Am. Jour. Bot. 6: 387-400. pl. 1. 1919.*

Conflicting statements have been made in the literature about the distribution of sex organs in this moss. Many have claimed that it is strictly

dioicous; more recent work has tended toward the conclusion that for the most part it is monoicous. Miss Brown made an immense number of single spore cultures in pots, and studied the behavior in the formation of sex organs. Some of the cultures ran for two years. She concludes that *Funaria hygrometrica* is strictly monoicous, but with considerable variation in the position of the sex organs. Usually the antheridia appear first, and at the apex of the main axis, while the archegonia develop later at the ends of branches. In some cases the gametophore is unbranched and produces either antheridia or archegonia; when branches are formed they may bear either kind of sex organs. But in every case the spores, protonemata, and gametophores are bisexual in their potentialities.

WINDFIELD DUDGEON.

Printed and Published for the Proprietor by J. B. BUTTRICK at the Methodist Publishing House, Mount Road, Madras.